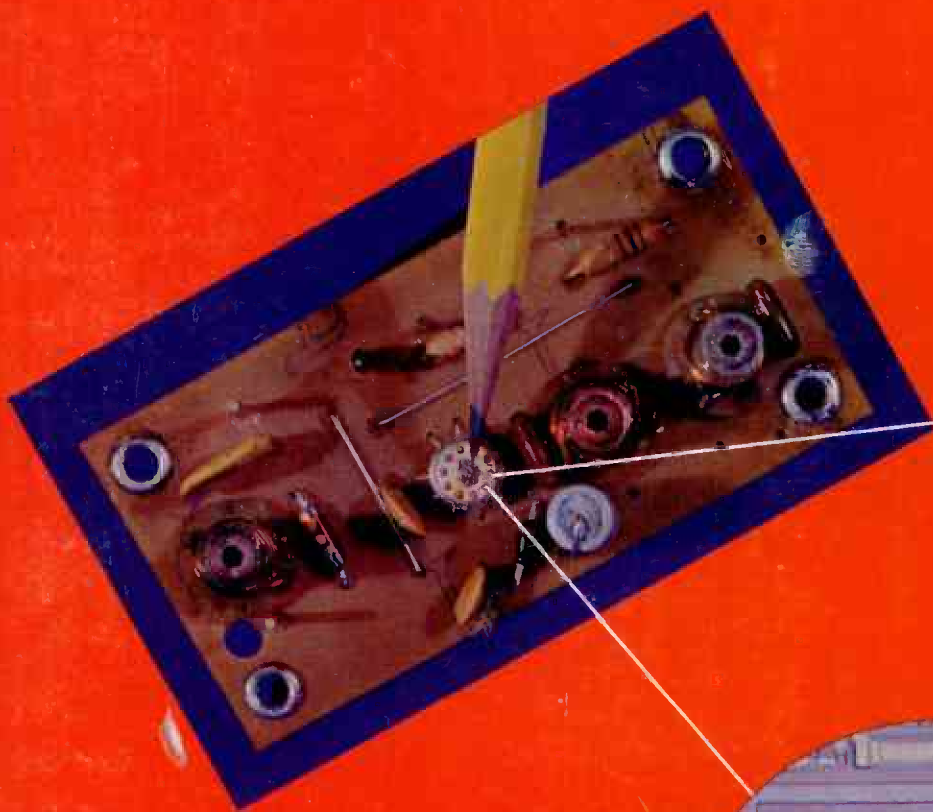
A HOWARD W. SAMS PUBLICATION

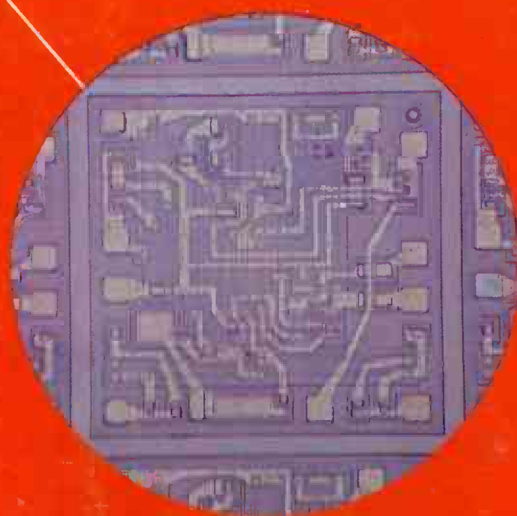
JUNE, 1968 | 75¢

PF Reporter®

PHOTOFACT

the magazine of electronic servicing





SOLID-STATE ISSUE featuring:

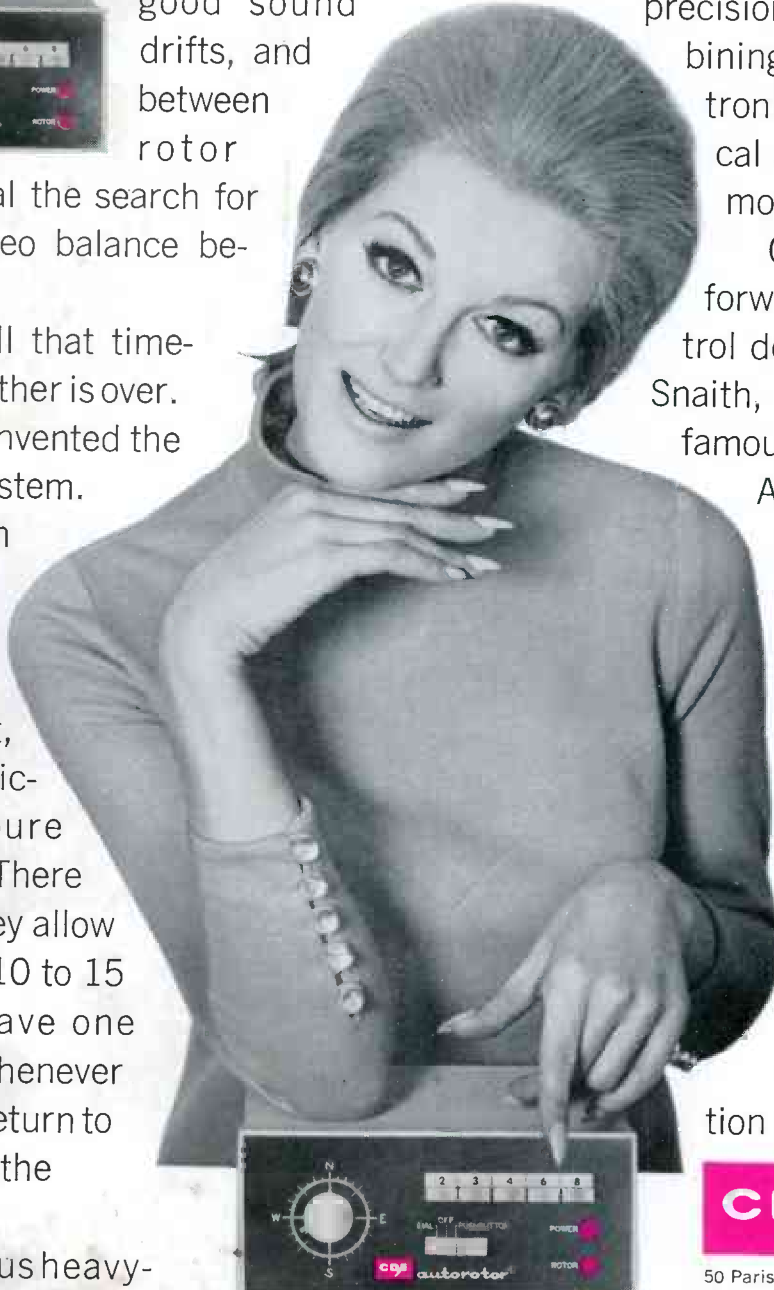
Transistors: A Report on the State of the Art
Troubleshooting Techniques for Transistor TV
The SCR As a Horizontal Gate Control Switch
How Are You And Progress Getting Along?
Solid-State Devices—A Refresher
Transistorized AGC

REMEMBER TO ASK—
"WHAT ELSE NEEDS FIXING?"

The name of the game was hide and seek.

The good color picture hides. The viewer looks for it. And sometimes it takes quite a while to find. The good sound drifts, and between rotor and tuning dial the search for a perfect stereo balance begins again.

Well now all that time-wasting and bother is over. Because CDE invented the Autorotor™ system. It's more than an ordinary rotor. Buttons are easily set for clear, bright, perfect color pictures. And pure stereo sound. There are five and they allow you to pre-set 10 to 15 channels. Leave one channel and whenever you choose to return to it, just press the button again.



CDE's famous heavy-duty Bell Rotor gives you high repeatability and no antenna drift. It's an all-solid-state, silent operation. The Autorotor system's precision is within 1° and combining it with pushbutton electronic control, not mechanical control, makes it today's most advanced rotor.

CDE took another step forward in the Autorotor control design. They had William Snaith, of Loewy-Snaith, world famous designers, create the Autorotor console. He made it attractive. Made it so you can place it on a table top or shelf without it being an eyesore.

This is the story you can tell your customers to sell the top-of-the-line in rotors. The latest advance from the quality house of rotors — Cornell-Dubilier.

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CDE CORNELL-DUBILIER

50 Paris Street, Newark, New Jersey 07101

"Remember to ask what else needs fixing"

See us in Booths 2214, 2215 & 2216 at the NEW Show.

Circle 1 on literature card

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Guaranteed means a full *12-month* warranty against defective workmanship and parts failure due to normal usage. That's 9 months to a year better than others. And it's backed up by the only tuner repair service authorized and supervised by the world's largest tuner manufacturer—Sarkes Tarzian, Inc.

Four conveniently located service centers assure speedy in-and-out service. All tuners thoroughly cleaned, inside and out . . . needed repairs made . . . all channels aligned to factory specs, then rushed back to you. They look—and perform—like new.

Prefer a replacement? Sarkes Tarzian universal replacements are only $10.45, customized replacements $18.25. Universal replacements shipped same day order received. On customized, we must have original tuner for comparison purposes, also TV make, chassis, and model number. Order universal replacement by part number. Send orders for universal and customized replacement tuners to Indianapolis.

Part #	Intermediate Frequency	AF Amp Tube	Osc. Mixer Tube	Heater
MFT-1	41.25 mc Sound 45.75 mc Video	6GK5	6LJ8	Parallel 6.3V
MFT-2	41.25 mc Sound 45.75 mc Video	3GK5	5LJ8	Series 450 MA
MFT-3	41.25 mc Sound 45.75 mc Video	2GK5	5CG8	Series 600 MA

Genuine Sarkes Tarzian universal replacement tuners with Memory Fine Tuning—UHF Plug in for 82-channel sets—Pre-set fine tuning—13-position detent—Hi gain—Lo noise—Universal mounting

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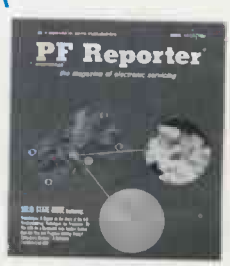
VOLUME 18, No. 6 JUNE, 1968

CONTENTS

ABOUT THE COVER

The minute size of the integrated circuit (IC) is dramatically illustrated in the three insets on this month's cover photo. The IC shown is used in the automatic fine tuning (AFT) system employed in various RCA color TV chassis.



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Look...but don't count!

Now...if you can guess (within 100 types) how many Amperex receiving tube types there are listed on this page... you'll qualify for our drawing and you may be one of a hundred winners of the world-famous Norelco Speedshaver or Lady Norelco.

Stop Counting! You're on your honor. We'll give you some clues without spoiling the fun. We can tell you that the line includes more than 650 Amperex-quality, U.S.-made tubes . . . plus the popular line of imported interchangeable types including the famous FRAME GRIDS and other Amperex proprietary tubes . . . plus the most complete line of European replacements for the imported car and home radios and hi-fi sets that you service.

Here are the simple rules of this simple contest. Look . . . but don't count the tubes listed on this page; then, by letter or postcard, mail your "best guess", postmarked no later than July 31st, 1968, to: The D. L. Blair Contest Mgt. Corp., P.O. Box 288, New York, N.Y. 10[illegible]

That's really all there is to it! All entries with the correct answer, (give or take 100 tubes) become eligible for drawing of prizes on August 12th. Please print your name and address legibly and include the name and address of your Distributor. Only one entry allowed per contestant. This contest, limited to TV, radio and hi-fi Service Dealers and Technicians is subject to Federal, State and Local laws and regulations and is void where prohibited by law.

Amperex

AMPEREX ELECTRONIC CORPORATION, HICKSVILLE, L.I., N.Y.

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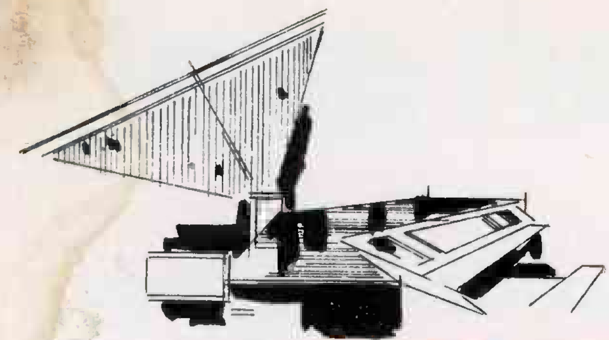

THE ELECTRONIC SCANNER

Industry-Wide Promotion of Color

"Discover Color TV" will be the theme of the first in a series of year-round, industry-wide promotions announced by the Electronic Industries Association's (EIA) Consumer Products Division.

The color television promotion, which will mobilize all elements of the industry at national and local levels around the "Discover Color TV" theme and an accompanying logo, is now in preparation for introduction to the general public in mid-September, 1968, according to an announcement by Charles N. Hoffman (Warwick Electronics, Inc.), chairman of the EIA Consumer Products Division.

"We feel that the time is right for an industry-wide promotional effort because of the broad base of support that is now available," Mr. Hoffman explained. "The fall of 1968 promises to be an excellent time for industry forces to pull together. The favorable outlook for color television is enhanced this fall by the general public interest in the Mexico City Olympics, the national elections, as well as the perennial interest in the World Series, the opening of the 1968 football season, and the introductions of new network television shows. All these factors make the fall of 1968 a very promising marketing opportunity for television, which represents about half of the $5 billion consumer electronics industry."

Mr. Hoffman emphasized that the "Discover Color TV" promotion is the first of many elements in a new, continuing public relations program recently announced by the Consumer Products Division. It will be followed by a spring promotion for portable electronic products. The Fall Color TV promotion, the 1968 Consumer Electronics Show (June 23-26), the present Service Technician Development Program, and publication of a new annual consumer electronics informational brochure this spring are the major ingredients of the current industry promotional efforts of the division.

"All of these elements in our total program," Mr. Hoffman pointed out, "are designed to help all segments of the consumer electronics industry to better serve their markets."

A major effort will be made to unify the marketing efforts of color television set manufacturers as well as such allies as trade associations, industry suppliers, and public utilities.

The "Discover Color TV" promotion will be followed in the spring of 1969 by another program in behalf of portable television, radios, phonographs, and tape equipment.

STDP Program Moves Along

"Project Transition", the Department of Defense-inspired program to train soon-to-be discharged GIs in civilian skills, is enabling the Electronic Industries Asociation's Consumer Products Division Service Technician Development Program (STDP) to realize its goal earlier than expected.

The Service Technician Development Program is the manufacturer-sponsored, long-term program to increase the numbers and the quality of consumer electronics service technicians. The STDP foresaw a slow process of career guidance efforts on the secondary school level of teacher and curriculum upgrading in consumer electronics and of image building for the local electronic service technician before any real effect could be discerned on the local level in servicing improvement.

Cooperation with "Project Transition," however, is speeding up the process. Within a few weeks, some twenty Army and Navy men awaiting separation will have certificates accrediting them as television repairmen trained in an STDP designed and conducted course. They will have been through a specially designed 18-week course held at the Great Lakes Naval Training Center near Chicago.

This first pilot STDP-Project Transition effort will soon be extended to as many as a dozen military installations in the United States.

The fruitful cooperation between the Department of Defense and the EIA Consumer Products Division came about as a result of contacts with Federal government departments and agencies early in the development stages of the STDP. The speed with which the industry and the government officials implemented their thinking can be gathered from the fact that initial conversations took place in mid-December 1967 and the first military students walked into the first session of their specially-designed course in early March.

STDP Director of Education and Training, R. W. Tinnell, is handling liaison with the many Chicago-area

industry companies who have cooperated in the Great Lakes Naval Training Center effort.

The Project Transition effort is only one segment of the Division's long-range Service Technician Development Program. Currently, a career guidance film is being produced by the Hugh G. Peters Company of Philadelphia for showing to about a quarter of a million secondary school students a year. Simultaneously, a brochure is being prepared to accompany the film or to be used independently. Both the film and the brochure explain the benefits, advantages, and satisfactions a career in consumer electronics servicing can afford.

The curriculum upgrading and teacher-training aspects of the STDP are also getting attention. Some fifteen to twenty college-based teacher seminars are being planned for the summer of 1968 under the general direction of Professor Frank Steckel of Appalachian State University, nationally known authority in electronics education and consultant to the STDP.

The general goals of the Service Technician Development Program are:

1. Career guidance
2. Encouragement and aid to schools and school districts wishing to establish new service technician training programs.
3. Assistance to schools with existing programs.
4. Technical assistance to in-service teachers.
5. General industry promotion and encouragement.

Answer To X-Radiation Scare

As an offshoot of their Safe Service program, the National Alliance of Television and Electronic Service Associations (NATESA) has initiated a program to provide color TV owners and prospective color TV buyers with "industry" facts on the X-ray radiation currently associated with color TV. NATESA has received many inquiries which they feel indicates that the public has been alarmed by the charges of X-ray radiation in color TV sets. Because of this "scare", many people who were ready to purchase color sets are delaying their purchase, while many people who have invested in sets are limiting their use, thus depriving themselves of full use of their investment.

Each inquiry directed to NATESA will be answered with a one-page fact sheet outlining NATESA's opinion of X-radiation as it relates to color TV. Also included with each response will be a NATESA booklet titled "Joys of Electronic Living", which explains television and answers the questions most often asked by laymen.

Following is an excerpt from NATESA's fact sheet titled "X-Ray Radiation In Color TV Sets":

"Specifically, there is NO known danger to you in viewing a color TV set, especially under normal viewing conditions. So do not deny yourself the extra joy of owning and/or viewing any color TV set of your choice.

"We Do urge that you do have your color TV high voltage measured and properly adjusted as soon as your very busy technician can get around to it."

New CRT Warranties

Sylvania Entertainment Products, an operating group of Sylvania Electric Products Inc., has announced a two-year warranty on color picture tubes in all Sylvania television sets purchased on or after April 22, 1968. Gordon C. MacDonald, Vice President-Marketing for the group, said the new warranty will cost TV dealers $7.50 foı 23″ color sets: $7 for 20″ sets, and $6.00 for 18″ sets. The warranty change does not affect receiving tubes, parts, and other components. Mr. MacDonald said.

Zenith color picture tube warranties have been extended to two years. Walter C. Fisher, president of Zenith Sales Corporation has announced that the extended warranty for a selected group of receivers, introduced earlier this year, is being made with no increase in prices. Included are 10 models from the "Z" line which will be enlarged in June and three "Y" line 18″ sets.

Certificates covering the extended warranty's second year will be provided distributors and dealers on all other current color line models, including "Golden Anniversary" (GA) special models, at the additional costs of $6 for 14″ and 18″ models and $7.50 for 20″ and 23″ models. Under the two-year color picture tube warranty, as under the one-year warranty, service, labor, and transportation continue to be the responsibility of the consumer. All other parts and components continue under a one-year warranty. All models in the new color TV line to be introduced in June will carry the two-year warranty, and will be priced to reflect the additional cost, Mr. Fisher stated.

Admiral has increased the warranty on color picture tubes used in current models from one year to three years. This warranty applies to all 1968 models that were in distributors' and dealers' inventories as of specified dates in March, 1968, provided that the consumer mails in his warranty registration card promptly upon delivery. When the registration card is received, Admiral mails a warranty certificate (specimen shown here) to the consumer if his set was listed in a distributor or dealer inventory.

Friend of Service Award

Zenith Radio Corporation, for the sixth consecutive year, has been presented the "Friends of Service Management" Award by the National Alliance of Television and Electronics Service Association (NATESA). Zenith is the only television manufacturer in the history of the award to have received it six consecutive times.

The 1967 plaque was presented to Zenith for "Outstanding Service in Creating Better Customer Relations." The presentation was made during the NATESA Spring Delegates Meeting and 9th Annual TESA of Wisconsin Convention in Milwaukee, April 27. Brian J. Marohnic, Zenith's national service manager, accepted the award on behalf of Zenith from Frank Moch, executive director at NATESA.

Mergers and Expansions

Automatic Radio Manufacturing Co., Inc., has announced that construction is about to begin on a 60,000-square-foot plant in Brook Park, Ohio, a suburb of Cleveland, which will be the new home of its wholly-owned subsidiary, New-Tronics Corp., a manufacturer of automobile radio and mobile communications antennas.

The new facility, said David Housman, Automatic Radio president, is being built to the company's specifications by Cuyahoga County and financed with industrial development mortgage bonds sold by the County. When it is completed in the fall, new-Tronics Corp. will occupy the spacious, one-story headquarters under a long-term lease. The company is presently located in a multi-story industrial building in Cleveland.

Plans for construction of a new plant and formation of a new subsidiary has been announced by **Tenna Corporation,** Cleveland-based manufacturer of automobile sound equipment, antennas and fractional horsepower motors. According to Morton B. Mendes, president, the new 10,000-square-foot facility will be erected at Caguas, Puerto Rico on a site adjacent to existing Tenna facilities. The plant will house Tennamatic, Inc., the newly formed subsidiary.

New Motion Picture

A new film titled "So You Want to Be An Electronics Technician" was produced in association with the National Alliance of Television and Electronics Service Association (NATESA), the National Electronics Associations, Inc. (NEA), and De Vry Institute of Technology, a subsidiary of Bell & Howell.

The film shows the important role of the electronic technician in the world in which we live. It gives a broad overview of the field, sets forth the requirements a student should have, and reveals the opportunities for the young viewer in such areas as Servicing, Manufacturing and Maintenance. It suggests the status and income which accompany this occupation and the many opportunities for advancement. ▲

Circle 8 on literature card

A MESSAGE FROM THE MANAGING EDITOR—

Things are happening in the service industry! During the past several months, the consumer electronic servicing segment of the electronics industry has made commendable progress in the areas of pricing, organization, and improvement of the general public's image of the service technician.

While it is probable that the results of this progress have not been felt by every service technician, it is certain that within a short period of time increasing numbers of service technicians will come to realize and share in the proceeds to be reaped from the present face-lifting efforts of the industry—provided every service technician participates in the program, either as an active member of an industry association and/or through his individual business activities.

At the present time, there are a number of self-improvement and business-stimulating programs under way within the servicing industry. Many of these programs were initiated by and pertain primarily to the servicing segment of the electronics industry. Such servicing-oriented programs are needed and are proving effective in overcoming the problems that relate only to consumer electronic servicing.

However, there are other problems that involve all areas of the electronics industry and, consequently, demand the combined efforts of all members of the industry—manufacturers, distributors, service dealers and technicians.

One such problem is the current decline in replacement parts sales. This decline, which has occured despite the continued increase in the sale of consumer electronic products, affects not only the manufacturers and distributor, but also the service technician.

There are many underlying factors that contribute to the decreased demand for replacement parts; however, the most obvious reason is that fewer older electronic units are being repaired in relation to the number of new units that are being purchased. Undoubtedly, many of the older units are discarded when they wear out or are replaced by a new unit. But what about the older units that have not been thrown away but, instead, have been stored away for repair at a later, more convenient date? Herein lies a waiting market for the service technician's services.

To tap this waiting market for the technicians services, and thereby create an increased demand for replacement parts, the Distributor Products Division of the Electronics Industries Association (EIA) has developed a nation-wide program to encourage service technicians to solicit additional business on each and every service call by asking the customer "What Else Needs Fixing?" This simple question, which has appeared—and will continue to appear—on the front cover of PF REPORTER, has been adopted as the slogan for EIA's Sell-Service campaign.

The Sell-Service program is based on the fact that many homes contain radios, TV's, stereos, tape recorders, and other home entertainment products that are in need of repair but, for one reason or another, have been stored away in a closet, garage or basement and forgotten. Many of these units were not repaired (or even diagnosed for that matter) at the time they failed because the owner either replaced them with a new instrument or decided to do without them because he mistakenly assumed that the cost of the repairing the item would be prohibitive.

For example, the owner of a defective tape recorder fully intends to have the unit repaired the next time he has to call a service technician. However, since the tape recorder is not a high-use item for this particular owner, he stores the instrument away in a storage closet and forgets it. In a couple of months, his color TV develops trouble and he quickly calls a service technician to repair the set before the wife and kids make life a little less enjoyable for him. In the excitement of getting the color receiver and his living pattern restored to normal, the customer completely forgets about the defective tape recorder. If, at this point, the service technician had asked the simple question "What Else Needs Fixing?", the customer probably would have remembered the tape recorder. Not only would the technician have gained extra business, but he would have let the customer know that he is definitely interested in additional business. Such communication between service technician and customer stimulates business.

Recently, with the cooperation of electronics distributors, the EIA Distributors Products Division tested the Sell-Service program for a four-week period in the Indianapolis area. Various service technicians were introduced to the Sell-Service program and supplied with printed promotional material such as banners, signs, pocket protectors and stickers carrying the slogan "What Else Needs Fixing?" Results of the test indicated that the service technicians who actively participated in the program increased their business over 7½% during the test period.

It is evident from these results that the Sell-Service program does, indeed, live up to its name when properly executed by the electronics industry member who is ultimately responsible for its success or failure—the service technician.

The immediate future of the consumer servicing industry rests, for the most part, on the active participation of the service technician in the various programs to promote continued improvement in all areas of the electronic industry. Such programs, if given proper backing, can contribute immeasureably to both the present and future prosperity of the electronic servicing industry.

So, participate in your industry's programs. Begin by remembering to ask "What Else Needs Fixing?" during your next contact with a customer. You'll probably be a lot busier—and richer—because of it. ▲

The replacement business, of course! Six new silicon power transistors can put you immediately into the expanding hi-fi and stereo solid-state replacement business. And, the addition of four new silicon rectifiers equip you with a full line of 1 A units with PRV ratings ranging from 200 V to 1,000 V—ideal for servicing radio and television.

RCA's SK-Series Transistors, Rectifiers, and Integrated Circuits now total 31 individual units. They can replace approximately 10,000 solid-state devices. This quality line is manufactured specifically for replacement use. There are no castoffs. No factory seconds. No unbranded culls. These are truly "Top-Of-The-Line" replacements!

See your RCA Distributor today about your supply of RCA SK-Series replacements. Ask about RCA's Replacement Catalog, SPG-202E (a complete cross-reference of foreign and domestic types), and the RCA Transistor Servicing Guide.

RCA Electronic Components, Harrison, N. J. 07029

RCA

These 10 SK devices can bring you added business

Circle 9 on literature card

TRANSISTORS

Part-1

A Report On The State of The Art--

the evolution of the design and application of semiconductors

by Jack Darr

The transistor made its first public appearance in consumer electronics in the small portable transistor radio. The switch to transistors has progressed so far that tube radios are now a rarity. Even the word transistor, to the public, now means a small personal radio. The transistor is ideally suited to this kind of use. The very low power consumption of the transistor and the elimination of heater-power requirements allowed the development of extremely compact radio receivers.

From this beginning, the transistor found its way into the auto radio, where it first functioned as the output stage in hybrid sets (part tube-part transistor), and then eventually took over all functions.

Next the transistor invaded the phonograph amplifier field, including the hi-fi branch, where it started a truly massive argument: "Is 'transistor sound' the equal of 'tube sound'?" This argument raged hotly for a while, then gradually settled down. Today, the transistor is quite at home in the highest of hi-fi, although the tube is still holding its own, especially in the very high-powered areas. However, today's transistor can deliver a very respectable power level; transistor ampilfiers are being made with power outputs up to 150-200 watts. A visit to the nearest discotheque (equip yourself with earplugs) will convince you of this fact.

The subminiature radio has finally made an old science-fiction prediction come true — the one about the electronic gadgets that were made so cheaply that they could be thrown away rather than repaired. Under present-day conditions, this is quite true. The 4-transistor radio sells for about $5.00. The working service technician cannot make repairs to one of these "mini-monsters" for less than about $7.50 (that is, any job requiring a half-hour of bench time, and the location and replacement of a faulty part — transistor, IF transformer, etc.). When a whole new radio can be bought for $5.00, the conclusion is obvious. This is fine with most service technicians. (Given the choice of working on one of these sets or having a boil on our nose, most of us take the boil.)

Transistors in TV

The transistor sneaked quietly into TV circuits quite a while ago. The first intrusion of solid-state in TV circuits was the original point-contact diodes used as video detectors. Then came the horizontal AFC diode units of fond memory. ("Why is the blanking-bar locked in the middle of the screen, Daddy?") Early diode assemblies weren't too reliable; however, the later ones work very nicely.

Transistors began to show up as triode amplifier stages in the 1966 model TV's. Probably the first use was a "middle video", or Y-amplifier stage, in color sets; Sylvania, Zenith and others used it. Then, the transistor began to show up in noise amplifiers, noise-gate stages, and color killers, etc. Motorola used a transistorized UHF tuner in their TS-914 chassis, while many others employed UHF diodes as mixers in UHF tuners.

Later on, completely solid-state, black-and-white TV sets were built. The first ones were miniature import models; however, the U.S. set-makers got into the act very soon, with somewhat larger but still highly portable chassis. Now, several makers (Magnavox, RCA, Motorola, etc.) have conventional, table-model, solid-state TV chassis. Motorola's TS-915 color chassis is completely transistorized, with the exception of the high-voltage rectifier (and the picture tube, of course).

Diodes

The happy little peculiarities of the solid-state junction diode makes it extremely useful in all kinds of circuits. You'll find them in great numbers, in both tube and solid-state TV sets. They do about everything you can think of—blanking, regulation, protection of various circuits against overload, etc.

The diode, with appropriate bias, can be used as a switch that won't turn on until there is a certain value of voltage across the circuit. The triggering voltage can be anything from 1 to 2 volts in an RF AGC circuit, to 100 volts or more in a high-voltage bias regulator or horizontal-output tube protection circuit. As an example of the use of solid-state diodes, in the Motorola TS-460 all-transistor portable TV a diode serves as a boost rectifier that provides 100 volts for the collector of the video-output transistor. The same diode also serves as a protective device for the horizontal-output transistor, Q20.

During horizontal retrace, pulses from the flyback flow through X3 and charge capacitor C71 to a level of 100 volts. This voltage reverse-biases the diode so that it will not conduct until the circuit voltage on its anode goes higher than 100 volts. If there is an arc-over in the circuit —for instance, a reverse breakdown in the high-voltage rectifier—there will be an undesirable voltage surge in the circuit; one which could exceed the voltage breakdown rating and destroy the horizontal-output transistor (by forward-biasing its emitter). However, the faithful diode won't let this happen. As soon as the voltage surge goes over the 100-volt level, the diode instantly begins to conduct. The excess voltage is then harmlessly carried off in the form of the charges on C71 and C10. Thus, the diode has "clamped" the emitter circuit at a 100-volt level. Since the normal collector-emitter voltage on Q20 has a 150-volt breakdown rating, the 100-volt clamping level is still safe.

This diode clamping action is used in all sorts of other circuits. It is even used as a high-voltage regulator in one color TV chassis. The diode is connected in the horizontal-output tube's grid circuit and regulates the high voltage by varying the grid bias voltage of the horizontal-output tube.

Modularization

The minute size of the transistor and the development of the printed-circuit board finally allowed circuit designers to realize one of their dreams—modularization. Believe it or not, this idea first appeared in the early 1930's, when a radio set was designed with all plug-in units. For economic reasons, this approach to design fell by the wayside. However, it may turn out that the more modern design and the peculiarities of the transistor/PC board combination will make it practical now.

One major manufacturer (Motorola) has already produced a completely transistorized color TV set employing plug-in circuit modules. However, it should be pointed out that the modules employed in this chassis are not the throw-away type. Their main function is to allow "instant servicing" on the color chassis. When the fault is isolated to a particular module, that module is taken out and a good one plugged in. The defective module is then taken back to the shop, the bad part located and replaced, and the module is ready for use on the next job. This eliminates one of the major faults of the original concept: No real service technician could stand the idea of "throwing away all of those good parts" just to get rid of one bad one.

At present, aside from the normal modularization of all PC board units, the previously mentioned chassis is the only major use of the "plug-in" concept. Whether or not Motorola's plug-in modular design is a success will undoubtedly affect future chassis designs.

Integrated Circuits

The last word in modularization, of course, is the integrated circuit (IC). These contain in one extremely small package not only the active elements (the transistors) but almost all of the passive elements (resistors, capacitors, etc.) needed to perform a given function.

The IC, too, had a modest beginning in TV. The first applications were as the sound IF and FM detector circuits in RCA's 1966 color chassis. Now whole audio stages are being made in IC form. It will probably be only a short time until we start finding video IF, sync separator, color IF's, color demodulators and many other circuit functions in one IC.

So far, coils and tuned circuits must be external due to the difficulty of making inductors with IC fabrication techniques (depositing very thin layers of conductors, semiconductors, oxides and insulators on a tiny substrate) and their inherent size. However, in TV work, RF and IF coils are about the most rugged elements in the circuitry. Since they are comprised of only a few turns of large wire, they give very little trouble.

In future applications, we may find "resonant circuits" that use no coils at all. Such devices would not be resonant or "tuned" in the sense that we use the word now. They would operate as bandpass filters or as amplifiers (such as video IF's) by using bridged-T circuits in the feedback loops. Bridged-T circuits are made up of resistors and capacitors and thus are suitable for IC application.

Parameter Spreads in Transistors

In the original transistor circuits, design engineers came up against something new to them: the wide variation in electrical characteristics that exists among a batch of presumably identical devices. This is called "parameter spread." It means that, at that time, transistors did have a very large, normal variation in their electrical characteristics. For example, a certain type of transistor could have a small-signal, forward-current gain (beta, or H_{fe} for short) of anywhere from 50 to 100 and still be within limits for the type. Consequently, the design engineer had to keep his circuit design within this range so that it would not require "specially selected" transistors.

To a certain extent, this is still true; the life of a transistor design engineer is no bed of roses, even now.

Leakage ran high in the first transistors. Design engineers were faced with a host of problems, such as an extreme variation of gain with only a small change in temperature or leakage current. So they adopted a technique of "swamping out" these variations by designing the circuits so that changes in parammeters would have the least possible effect. The choice of the external resistors and the liberal use of feedback helped to give them the control of output that they had to have for practical designs. The development of temperature-sensitive resistors (thermistors, etc.) was a boon to the harrassed engineer.

By careful design, they were able to make one effect compensate for another — the "equal-but-opposite-reaction" effect. One example: The small resistor used in the emitter circuit of a common-emitter amplifier stage still looks like a "cathode-bias resistor" to the old-timers. In one sense, this is true; however, its most important function is temperature-compensation. If the ambient temperature goes up, the junction current rises; if the junction current rises, the junction temperature goes up, which makes the junction current go up, etc. The emitter resistor compensates for these effects by increasing the reverse bias on the base which, in turn, holds the junction current down within safe limits. This circuit action avoids one plague of early transistor designs—an effect called "thermal runaway", a name that accurately describes the action. As the transistor junction got hotter, the current increased, which made the junction get hotter and soon (meaning about 15 microseconds) the transistor was destroyed.

Many other specialized devices—zener diodes, clamp diodes, voltage-dependent resistors (varistors), etc.

—have been developed for the same use. We'll discuss these devices later in this article.

The design and application of transistor circuits have made tremendous progress in the past two or three years. Improvements in manufacturing techniques and bold design developments have played an important part in this progress. Parameter spreads have been drastically reduced, and leakage currents have almost disappeared (the modern silicon transistor shows no significant leakage for all practical purposes—only a few nanoamperes).

With the new transistors, the design engineers use the same basic design techniques they had to develop to make the early transistors work. So now, we can get transistor amplifiers that are highly reliable, noise-free, and capable of amazing performance. When an amplifier or transmitter can be made so reliable that it can be sealed up in a capsule and dropped into the ocean as a permanent part of an undersea cable, or shot into space in a statellite, it can be considered to be ready for the consumer market. In fact, one satellite unit that was supposed to cutoff within a specified period refused to quit. They were almost to the point of seriously discussing methods of shooting the thing down.

Parameter Spread and the Service Technician

It might sound as if parameter spread was of no interest to the service technician. After all, he doesn't have to design the things, just make them work again after they've quit. However, whenever a transistor must be replaced, parameter spread should be considered by the techinican. (Contrary to publicity during the early days, transistors do fail at regular intervals, as we have found out.)

There are several lines of "general replacement transistors": Motorola, General Electric, Sylvania, RCA, Workman, etc. Armed with a cross-reference list and only a small bench stock, the technician can replace a great many different types of transistors. There are also (for U.S. makes) factory-replacement transistors available from the set-makers' distributors. For domestic types that are not available and, above all, for the imported sets with "strange" transistors, a good general-replacement stock is a necessity.

With the great number of transistor-types in use today, it's often impossible to have the exact-duplicate replacement on hand. So, the working technician has a real need for the general-replacement line. It is estimated that between 13,000 to 30,000 different types of transistors are being made today. Selecting the right one is always a problem. We'll discuss this problem and its solution in more detail in later sections of this article.

Each replacement-transistor manufacturer provides listings and cross-reference catalogues of as many transistors as possible, with his recommendations as to replacement types for each one. These seem to work out very well. I have intentionally used general-replacement types in a good many cases, and they have all performed well.

Fortunately for the technician, the "swamping-out" design technique makes the average circuit far less critical than it normally would be. Of course, there will always be certain critical stages where exact-duplicate transistors must be used, just as there are with some tube types. For example, if the set uses forward-bias AGC, and the wrong type of transistor is installed in a controlled IF stage, it could result in a reversal of the AGC action. Gain would go up when it should be going down. This would be due to the transistor working on the steeply rising part of the base voltage/collector current curve (the part used for reverse-bias AGC), instead of near the saturation point at the peak of the curve (the part used for forward-AGC bias). Reverse-bias AGC transistors are generally rather low-beta types, while forward-bias AGC types have a good bit higher beta and a more steeply rising line in the low-voltage portions of the curve or at very small signal levels.

All in all, the design engineers have made good progress in the adaptation of solid-state devices to consumer electronic products. This has been relatively slow, as all real solid progress should be. Of course, there were those instances when the engineers tried to make the transistor do things that it wasn't ready to at the time, and the result was trouble for both the manufacturer and the service technician.

With everything considered, the designers have done a fantastic job. They have had to make a radical shift in their thinking. From working with high-impedance devices with fairly reliable characteristics, they were suddenly thrown into a group of devices with very low-impedance characteristics that wandered all over the ball park. This resulted in the inevitable confusion. However, as the design engineers continued to work with transistors and got used to their quirks and foibles, they did the same excellent job they have always done. Solid-state design is here to stay. We can look for a steadily increasing rate of "solidification" in the future.

Standardization

The big headache, not only for service technicians but for design engineers too, is standardization. Sadly enough, right now there isn't, by even the wildest stretch of the imagination, anything that resembles "standardization". They're trying to, but they simply can't catch up. If you doubt this statement, pick out of your PHOTOFACT file the schematic of any five transistor units and see if you can find the same transistor used in equivalent stages on any two of them.

A lot of manufacturers use "in-house" numbers—numbers applied to transistors that have been specially designed for a certain stage or purpose. These are assigned numbers peculiar to that one company, and which have no connection with standard transistor numbering systems. This is true not only of imported sets, but of many U.S.-built receivers as well.

Transistor manufacturers, of course, use "developmental numbers" for devices while they are being tested and during the first stages of construction. Texas Instruments, for example, assigns a "TI standard" number to a transistor when it has gone into production but has not yet been registered with the Joint Electron Device Engineer-

ing Council (JEDEC). This number is usually something like "TI-2064". If it is still in the purely experimental stage, an X will be added: "TIX-2064", etc. RCA uses a five-digit number for the same purpose: "RCA 44406", for example.

A JEDEC number indicates that the unit has been registered with the Council and can be considered as standardized. Devices that differ from one another in performance are identified by different type numbers. JEDEC numbers are assigned in a strict numerical sequence; first come, first served as it were. At this time, the only identification or classification attempted is by the first two digits. A component whose first two digits are "IN" is a diode or rectifier; a "2N" is a triode device (transistor), and a "3N" is a tetrode. JEDEC numbered components are now appearing with four digits after the identifying first two—probably due to running out of three-figure numbers.

JEDEC and the Electronics Industries Association (EIA) have done a great deal to bring order out of the chaos that was so prevalent in the early days. They have issued standards covering transistor cases, outlines and base connections; they issue summaries of diodes, transistors, and "Registered Bases and Outlines for Semiconductor Devices", as well as other publications of great assistance to the design engineer.

A greater degree of standardization would be a big help to the service technician, and no doubt to the designer as well. However, it doesn't look too hopeful at this time. Research goes on at such a furious pace, and new things come out of the laboratories so frequently, that we simply can't keep up with all of them.

So, as far as the service technician is concerned, we will probably have to rely on the wide spread of existing transistor parameters when we can't get exact replacements. As long as you can get inside the ball park, the transistor will probably work satisfactory—good old tolerance! The selection of replacements for unknown transistors will be covered later in this article.

Part 2 of this article will discuss current applications of solid-state devices in consumer electronics. ▲

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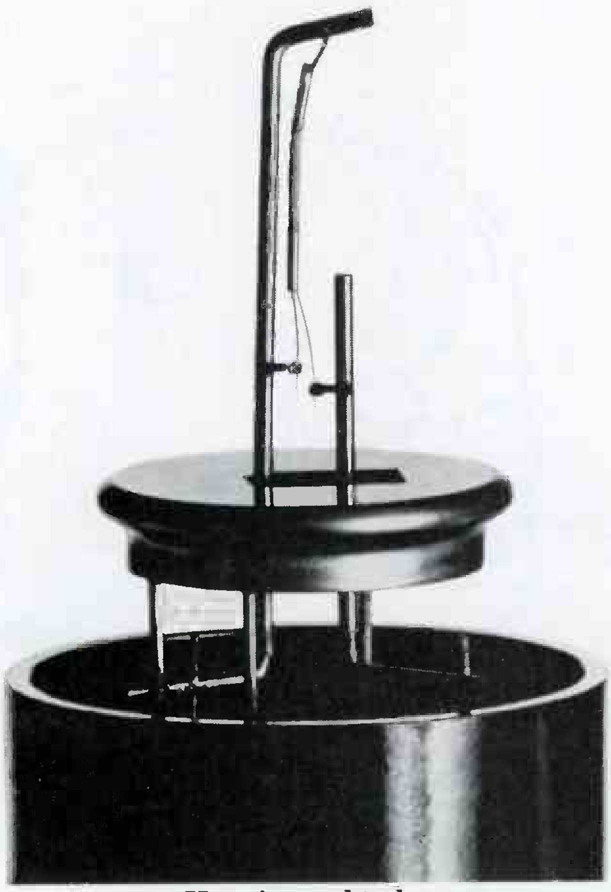

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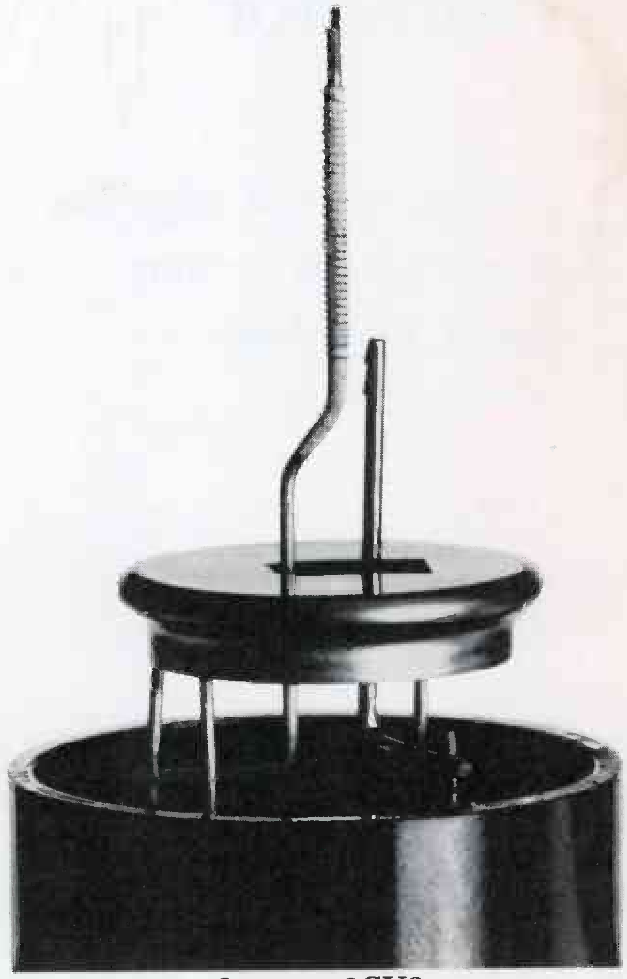

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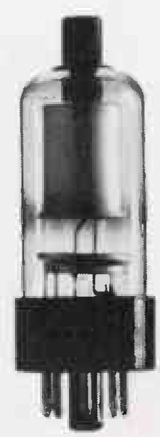

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Techniques for Troubleshooting Transistor TV

A few changes will adapt your present tube-type servicing methods to solid-state circuitry.

by Robert Heaton

To most service technicians, transistorized television receivers present more service problems than previous tube types. For example, in all-tube receivers one could easily change a tube, and in the majority of instances the instrument would be repaired. In transistorized television instruments, different service techniques must be employed. In the majority of transistorized equipment, all components—including transistors—are soldered in place. The technician cannot easily change or substitute transistors as an initial troubleshooting procedure. So when a symptom appears, it takes a knowledgeable service technician to quickly locate and isolate the defective stage. However, the service technician actively engaged in television repair (tube receivers) is automatically equipped for transistor television service. The only thing needed is additional training time to adapt the same basic servicing techniques utilized in tube sets to the servicing of solid-state receivers.

The logical approach for the technician troubleshooting transistorized equipment, is to use the same procedure he now uses for tube receivers. Transistorized television receivers process the same signal as tube sets. Therefore, the signal waveforms found in transistor receivers are quite similar to those in tube types. Also, the signals progress through the stages in much the same manner as in the tube set.

Forgetting for the moment the precautions you have learned about servicing transistors—overheating, soldering, connecting test equipment, etc. (just make sure all of these precautions are kept in mind)—let us investigate the overall circuitry used in transistorized television instruments and develop some servicing techniques to isolate troubles. Although the circuits in our examples won't be entirely typical of all types you will encounter, they will serve to acquaint us with basic techniques.

Ground Rules to Follow

Let us now establish a few basic ground rules of solid-state circuitry, but only those which are absolutely necessary to efficiently service transistorized equipment. We won't get involved with holes, electron flow, and so forth; here, we'll confine ourselves to the basic operating parameters the service technician needs to know.

Illustrated in Fig. 1 are the two basic bias conditions for transistor conduction. We illustrate only the common emitter configuration (most widely used), and the typical DC bias conditions necessary for the transistor to conduct—the normal voltages expected in a PNP or NPN circuit. Except in instances of injection voltages (such as encountered in oscillator circuits), the forward bias conditions for conduction in a PNP type require that the emitter be more positive than the base. If the reverse conditions exist—if the base is more positive than the emitter (in a PNP circuit)—the transistor is at cutoff.

To be conducting, the NPN transistor requires forward bias in the positive direction. That is, the emitter must be negative with respect to the base. (Although for clarity, we have omitted mentioning the collector voltage, it will be found that the same relationship exists in both PNP or NPN types. The collector will have the same polarity relationship to the emitter as the base.) In the case of germanium transistors (usually PNP type), the emitter-to-base voltage will normally be approximately .2 to .5 volts. Silicon transistors, usually NPN type, have a somewhat higher base-to-emitter voltage. Typical values for silicon transistors are from .5 to .8 volts. If we know the basic bias conditions for conduction in transistors, we can easily recognize when bias conditions are improper (indicating a defective stage.)

Some confusion often exists about the conditions that increase or decrease conduction in transistorized circuitry. For our purpose—an overall look at service techniques for transistorized circuits—we need to develop a ground rule that can be easily remembered. One of the points we should remember is illustrated in Fig. 2. Here, we show the parallel between the common triode tube circuit and the NPN transistor circuit. In other words, think of the NPN transistor as a vacuum tube in its relationship to a change in voltage. For example, in the tube circuit a positive-going voltage causes the tube to increase conduction. The same action is true for an NPN transistor—a positive-going change causes the transistor to increase conduction. The reverse action is also true; drive the grid circuit in a negative direction and tube conduction decreases. Likewise, if we drive the base of an NPN transistor in a negative direction, conduction decreases.

Once the NPN circuitry is firm in your mind, it is an easy task to mentally reverse the operating characteristics when a PNP circuit is encountered: An increase in voltage or signal injection in the negative direction turns the transistor on. This basic rule will often be utilized in transistor instruments. For example, in IF stages that are AGC controlled it is well to know how to cut off or turn on the transistor.

In transistorized television instruments, many circuits will be encountered in which the transistor will be operated as a switch. For example, Fig. 3 shows an NPN transistor serving as the color killer in a current television instrument. In this particular application, the color killer functions in one of two operating modes: The transistor is either cut off, or fully saturated. Here, we can adapt the basic ground rule we just established for transistorized circuits.

The actual circuit involves a PNP transistor in a common emitter arrangement. Initial base bias for the transistor is established by the oscillator grid and the killer threshold control—a network connected across the B+ supply. A simple divider network is used to adjust the fixed bias on the emitter. Collector supply voltage is obtained from the −100-volt source, with a voltage divider network to ground.

Under conditions of no color, the transistor is biased at cutoff—the base voltage in this instance is +.5 volts with respect to the emitter. Under these conditions, the collector voltage—due to the divider network from the negative supply—is approximately −20 volts. Since

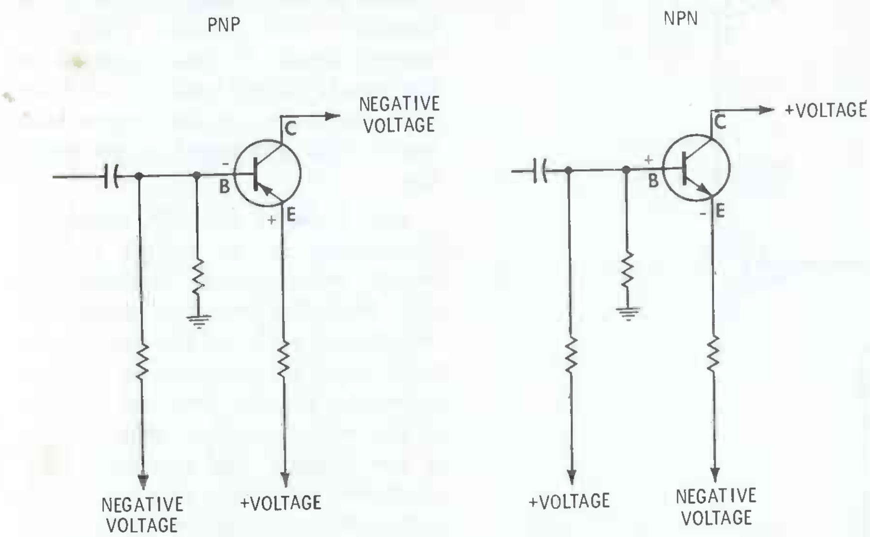


Fig. 1. Forward bias conditions for PNP and NPN transistors.

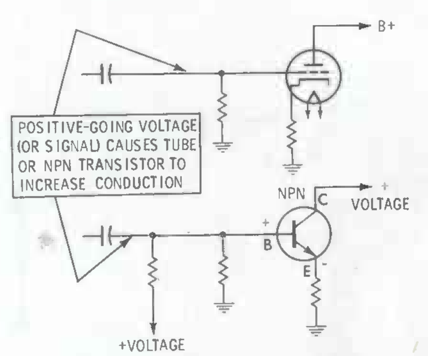


Fig. 2. NPN transistor and conventional tube react in similar manner to same input signal.

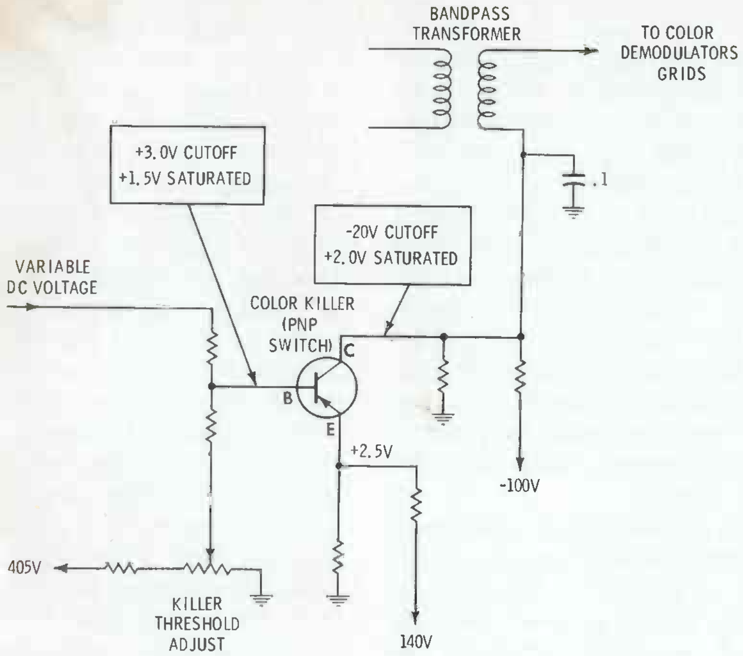


Fig. 3. Color killer circuit employing an NPN transistor.

the transistor is a PNP type, to cause conduction it is necessary to apply a more negative voltage to the base-emitter junction. With sufficient bias to the base, the transistor is easily driven into conduction. When a color signal is received, the DC voltage available to the base is altered to yield approximately +1.5 volts in the correct direction to cause conduction of the transistor. Under these conditions, the transistor becomes fully saturated, and the collector is clamped to the emitter voltage (less the small drop in the emitter-collector junction). The +2 volts produced is used to open the grid circuit of a tube demodulator.

It can be seen that our initial ground rule holds true: For a PNP transistor to conduct, the emitter must be positive with respect to the base. We have investigated the operation of the killer switch to illustrate the purpose of the circuit. This is another of our ground rules —try to analyze a particular transistor circuit to determine its function and purpose. If it is once established that the transistor is merely operating in a certain mode, the servicing of the circuit becomes quite simple.

Let us analyze the killer circuit from the troubleshooting standpoint. We know that the switch (transistor) is required to be either on or off. If we suspect that the color killer may be preventing color from reaching the picture, we need some means to disable the circuit to decide if the killer is indeed causing the trouble. Notice that under conditions of fully saturated transistor operation, the killer collector is virtually shorted to the emitter. Therefore, we can check the transistor switch circuit by merely connecting a clip lead from the collector to the emitter. This determines whether the killer circuit is the actual cause of the trouble. As a second check, we can apply a bias supply to the base of the transistor, adjust it to the normal operating voltage for saturation, and see if color appears on the screen. This latter test dynamically duplicates the change in bias voltage to see if the transistor will operate within its normal range. If color appears in the picture during both checks, then we concentrate on the stages that supply bias and signal to the killer base.

Fig. 4 shows an NPN transistor functioning as an on/off switch, though in an entirely different circuit. Here the transistor completes the ground path for the sync separator stage. The transistor is actually a switch in series with the emitter of the sync separator. When noise is not present, the transistor bias conditions are such that the transistor conducts, completing the emitter ground return. When noise pulses are present in the video detector

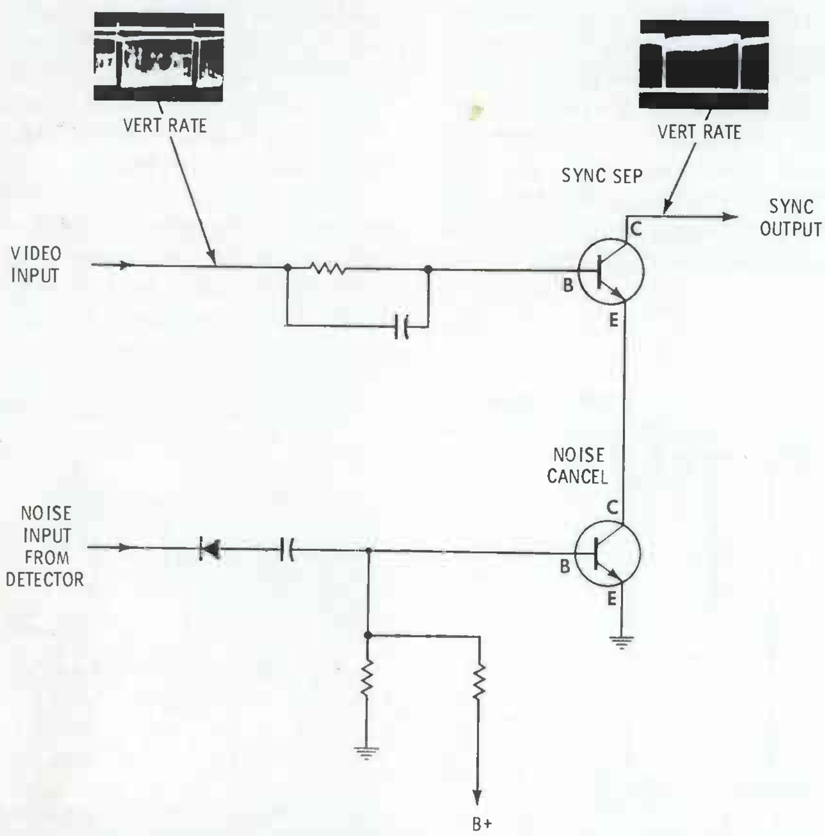
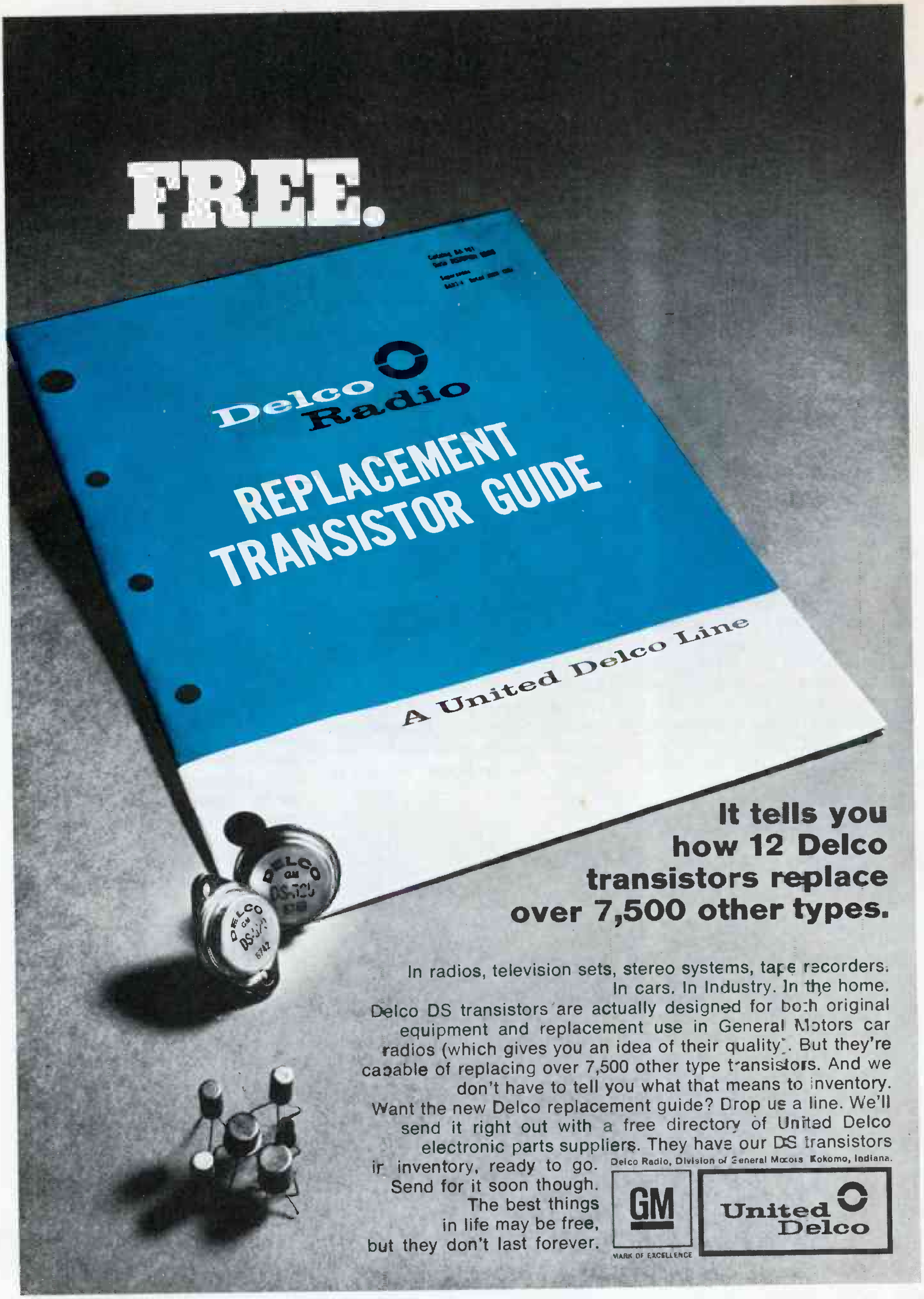


Fig. 4. Noise cancellation transistor completes ground path for sync separator.



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circuit, they are coupled through the diode and capacitor to the base of the noise cancellation transistor. The input signal is in the direction necessary to cut off the NPN transistor. In this instance we should know the type signal required: The transistor is an NPN type, normally conducting; to stop conduction, it requires the same input as would a tube grid circuit—a negative going signal.

Now, let us analyze the circuit to establish our troubleshooting techniques. We have determined that the transistor is normally conducting. If a transistor is normally operating in the conducting mode, and trouble is suspicioned, it is only necessary to connect the collector to the emitter to complete the switch circuit. This will indicate whether a poor sync condition is caused by the noise cancellation transistor or by a defective sync stage.

For example, the service technique may follow these lines when a symptom of poor sync appears on the screen: Using your oscilloscope and low-capacitance probe, check the waveform at the input to the sync separator. If a normal waveform is viewed at this point, check the waveform at the output of the sync separator. If the input waveform is normal, and the output waveform is distorted or missing, the noise cancellation transistor may be causing an erratic (or inoperative) sync separator stage. The next step is to short the collector and emitter of the noise cancellation transistor to see if it is causing the trouble.

At this point, it might be well to review the application of the oscilloscope to transistorized television instruments. Remember, initially we stated that the station signal is processed in a transistorized television in a manner similar to that in a tube type receiver. Thus, the waveforms viewed throughout the solid-state circuitry will be similar to those encountered in tube sets. Notice that, although the sync stage is transistorized, the input and output waveforms are virtually identical to those found in a tube-type sync separator.

Thus far, we have established a few of the ground rules to follow for transistor servicing. In addition, we have investigated a few service techniques involved when transistors are operated in the switching modes. The viewing of signal waveforms with the oscilloscope has been touched on slightly and will be used even more to establish our troubleshooting techniques. However, let us now concentrate on specific techniques used to isolate troubles in major sections of the receiver. Although it is impossible in the space of this article to fully describe all circuits and problems the service technician will be confronted with, we can establish that the techniques used in servicing transistor receivers are very similar to those used for tube-type receivers. Thus, we can learn to adapt the logical techniques we now use for tube-type receivers.

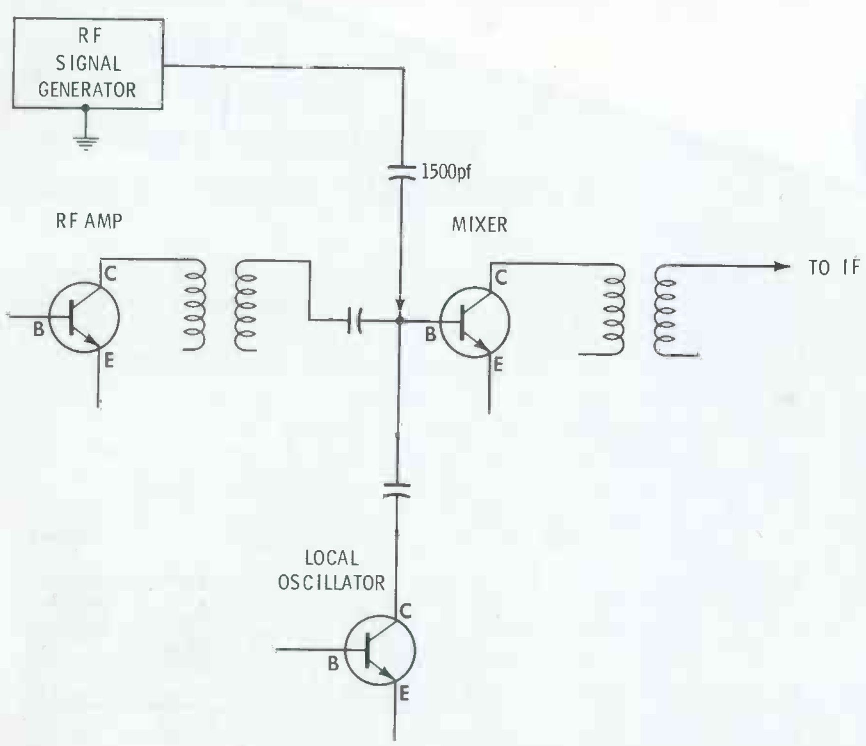

Fig. 5. Substituting generator signal for local oscillator output.

Isolating Tuner Troubles

The circuit functions of a transistorized VHF tuner are identical to those in a tube type. Included are an RF amplifier, a mixer stage, and an oscillator stage (usually using a separate transistor). In our example, we suspicion that the local oscillator in the VHF tuner is inoperative. The technique to use here is identical to that used by many service technicians for troubleshooting tube-type receivers—substitution for the local oscillator signal.

As illustrated in Fig. 5, the procedure is quite simple: Select one of the strong local channels in your particular area, and tune the receiver to this channel. Use a CW (unmodulated) signal generator, and set the generator output frequency at the oscillator frequency for the channel selected. (The oscillator frequency is equal to the sum of the station frequency plus the IF frequency.) For example, if the receiver is tuned to Channel 4, the oscillator frequency to select is 113 MHz. Keeping the generator output at a low level, inject this CW signal to the base of the mixer stage via a 1500-pf isolating capacitor. If the oscillator is defective, the picture will appear on the screen. The CW signal from the generator substitutes for the local oscillator injection signal, permitting the mixer to develop IF output signals. Most technicians have used this technique at one time or another, usually successfuly. The mixer stage in the VHF tuner can be checked with the same procedures used for locating a loss of signal caused by a defective IF stage—as will now be illustrated.

Video IF Stages

The procedures applicable for troubleshooting transistorized video IF stages vary; the choice de-

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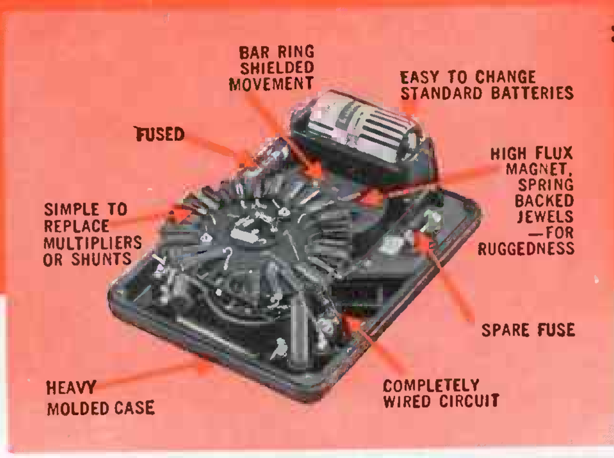

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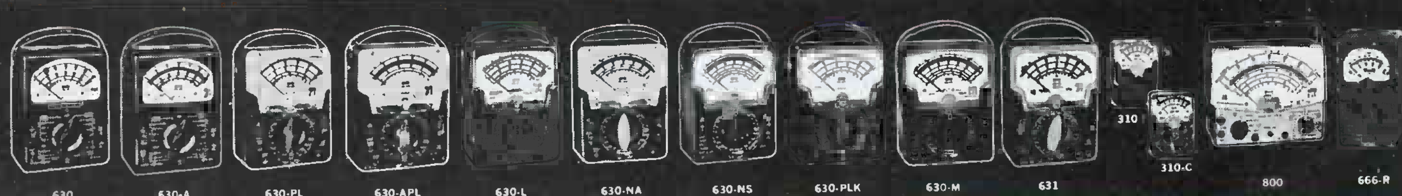

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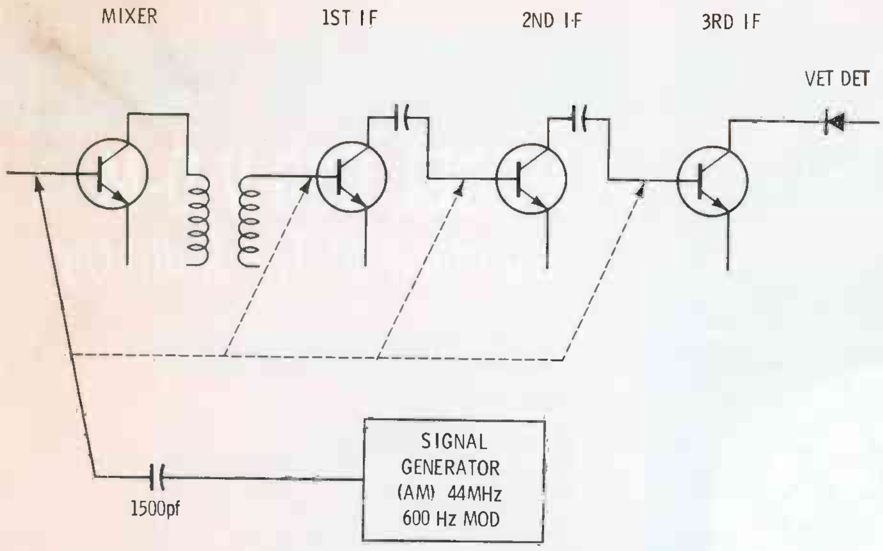


Fig. 6. Signal substitution in IF stages isolates break in signal path.

pends on the particular technician Several good techniques can be utilized, and often the best choice depends on the kind of trouble encountered. For example, some technicians prefer to signal trace through the IF stages using an oscilloscope with detector probe and a station signal. However, it is often difficult to view, with any clarity, the detected video waveform in the first and second IF stages. Normally, the signal at the third IF stage can be viewed with relative ease. Other technicians prefer to use a pattern generator, such as a color-bar generator. This technique also has its advantages and disadvantages. Many pattern generators of this type are not equipped with video IF outputs —although those that are so equipped are usually designed specifically for signal substitution techniques.

A simple procedure can be used to isolate an interruption in the signal path throughout the IF stages. Depicted in Fig. 6 is a simplified procedure using an AM signal generator. The technique is easily adapted to most any transistorized television instrument. It must be remembered, however, that we are trying to isolate a break in the signal path—a stage isolation technique. DC voltage checks are necessary once the defective stage is located. Here is the procedure: Set the generator at the center of the IF passband, and using a 1500-pf isolating capacitor, inject a signal, in turn, to the bases of the mixer, 1st IF, 2nd IF, and 3rd IF stages. In most receivers, the IF frequency will be in the 40-MHz range, so set the generator to 44 MHz, with some type of modulated signal impressed on the carrier. In our example, we are using a generator equipped with 600-Hz modulation.

The sequence of signal injection is entirely up to the technician. We prefer to inject the signal at the 3rd IF and proceed rearward to the mixer stage. If this sequence is utilized, be sure the output of the generator is attenuated as the additional gains of the stages are introduced. If the stage is operating, the signal will appear on the screen as dark bars. Once the defective stage is localized by this procedure, DC voltages will isolate the defective component(s). Use only enough generator output signal to produce a weak picture on the screen—avoid overloading to the point where the signal is virtually forced through the stage by capacitive coupling. Remember, we are trying to locate a stage causing the loss of signal; if the stage under test is operating, gain will be realized.

AGC Troubles

The same troubleshooting techniques applied to tube-type AGC circuits can also be applied to transistor circuits. If AGC trouble is suspicioned, it can be confirmed by making very simple checks. First, locate the stages that are AGC controlled. Now, referring to the service data for the particular chassis, measure the base and/or emitter voltages in that particular circuit. If the AGC circuitry is causing a particular IF stage to be cut off or overloaded, it will be indicated by the voltages on the transistor elements. For example, the simplified circuit shown in Fig. 7 illustrates an IF stage with AGC control voltage applied to the base circuit. The base voltage for this stage is approximately .6 volts to .8 volts under normal conditions. If for some reason the AGC circuit is inoperative, the AGC voltage (or lack of it) applied to the transistor will cause improper operation. It must be remembered that the upset bias conditions may be caused by the transistor circuitry itself. However, this can be confirmed by clamping the AGC supply.

Using a bias box or a battery supply, clamp the base circuit with the normal voltage, as shown on the service schematic. In Fig. 7, the bias box would be connected at the bottom side of the AGC input resistor and adjusted for a normal base voltage of .7 volts. Under these conditions, if the transistor was inoperative due to improper AGC action, a normal picture will be reproduced on the screen—indicating AGC trouble. Of course, detailed checks will then have to be made in the AGC stages proper This technique is very similar to that used in tube-type instruments, where the IF AGC line is clamped by a negative voltage. However, in transistor circuits the AGC bias may be either a positive or a negative voltage as indicated on the service schematic.

Video Stages

Fig. 8 depicts an acceptable technique for troubleshooting video am-

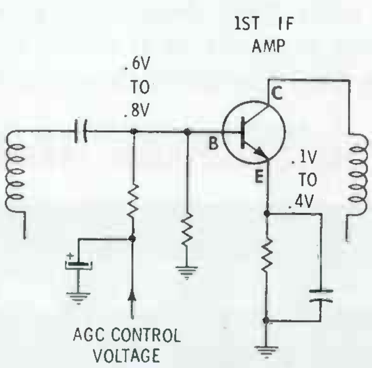


Fig. 7. IF stage with AGC voltage applied to base.

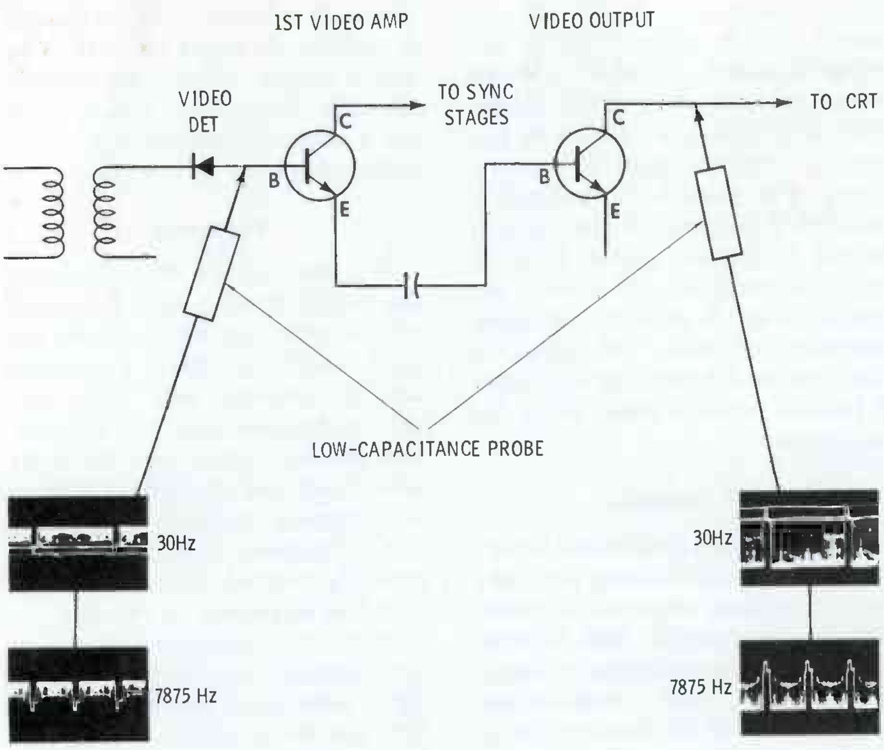


Fig. 8. A scope and low-capacitance probe localizes trouble in video amplifier.

first check should be for the normal waveform (shown in service literature) at the base of the vertical oscillator. Included in the waveform is a small tip indicating the vertical sync pulse. The pulse at this point can be viewed on the slope of the trace by adjusting the vertical hold control to lose sync. This waveform will indicate if a good sync pulse is reaching the vertical oscillator.

The intermediate stage—usually a driver stage—acts as a buffer amplifier to prevent loading on the vertical-output stage. Investigating the circuit, we find that the driver stage in this particular instance is an emitter follower. Thus, the waveform viewed at the input to the vertical driver base circuit will be the same as the one viewed at the output, since there is no inversion from the base to emitter.

A servicing advantage is gained in transistorized vertical-output stages because the drive signal at the output collector is of sufficiently small amplitude to permit measuring with an oscilloscope; thus, the waveform can be checked directly at this point. Notice that, in all respects, the waveforms viewed in transistorized vertical stages are similar to those in their tube-type counterparts.

If so desired, a signal injection technique can be used to locate a loss of vertical sweep, using the

plifier stages in transistorized television sets, using a station signal and oscilloscope equipped with a low-capacitance probe. Notice how this technique parallels the one presently used for servicing tube sets. The main point we are trying to illustrate here is that the same techniques may be used since the signal waveforms present in the video amplifier stages are identical in both tube and transistor sets. The procedure involves tuning in a station signal, adjusting controls, and scoping for loss or distortion of the video waveform. The familiar check point—output of the video detector—is a good place to begin. Once the defective stage is isolated, DC voltages will isolate the defective component.

Vertical Stages

No vertical deflection, poor linearity, unstable vertical sync, and insufficient height are all common troubles encountered in tube type receivers—and they are also encountered in transistorized vertical circuits. Troubleshooting procedures require the application of an oscilloscope—with low capacitance probe—to view the signal waveforms throughout the vertical circuits.

Transistorized vertical circuits (Fig. 9) can be slightly more involved than tube circuits because the stages encountered often include an intermediate driver stage. However, the same techniques utilized for tube sets are applicable. The

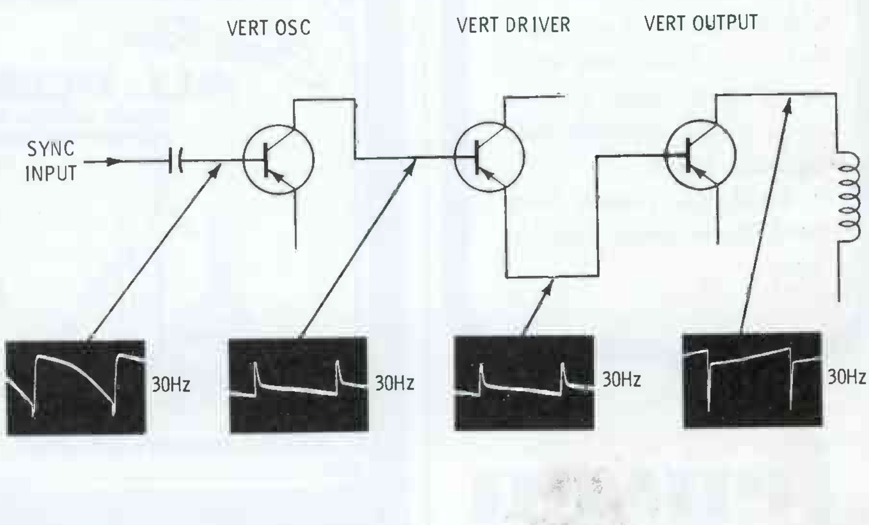


Fig. 9. Waveforms in transistor vertical circuits are similar to those in vertical circuits employing tubes.

same procedure and equipment as used in tube sets. A 6.3-volt AC source may be utilized—via an isolation capacitor—to inject a sweep waveform into the vertical stages. This technique can be used to isolate a complete loss of vertical sweep. For example, if a signal is injected at the base of the vertical-output stage, and some form of sweep appears on the screen, the output stage is probably in good operating condition. The signal, in turn, can be injected rearward until it fails to produce some sweep on the screen.

B+ Supplies

B+ shorts in transistorized equipment can be isolated using the common techniques employed in other circuits. For example, high currents are drawn in the horizontal, vertical, video-output, and audio-output stages. If a circuit breaker (or a fuse) is popping, and the short is not due to an electrolytic capacitor, the preceding stages are most likely at fault. The procedure to isolate the problem often involves opening B+ supply lines and checking to see if excessive current is being drawn. If a fuse or a circuit breaker is opening, it might be well to insert a current meter while troubleshooting. The proper current drain for a particular chassis is generally indicated on the service data.

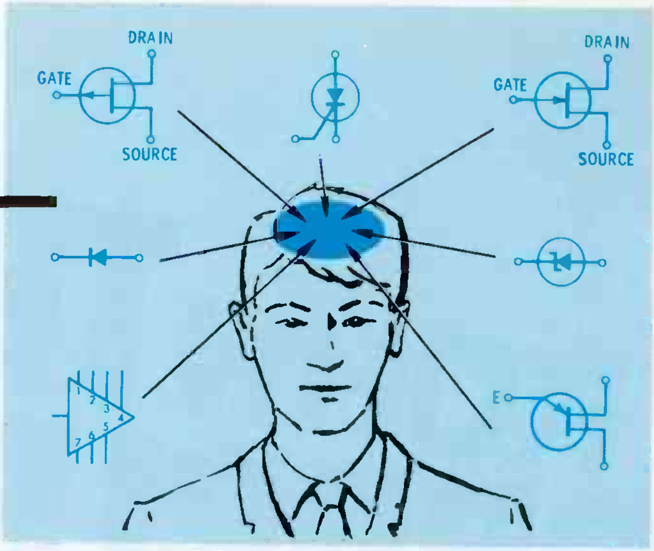
Summary

We have shown that, basically, the troubleshooting procedures used on transistorized TV receivers are quite similar to those procedures used on tube-type sets. Many specific techniques may be different. For instance, tubes may be freely substituted, but changing a transistor generally requires a soldering iron. Therefore, this technique is generally avoided until we are more than just suspicious of the part.

Many more techniques, however, are identical. Signal tracing, and signal substitution are both particularly suitable techniques when troubleshooting solid-state TV receivers. The most valuable tool, though, when servicing these sets, is the proper frame of mind. Remember, solid-state circuits are really no more difficult than tube sets. ▲

Solid State Devices — a refresher

Understanding the operation and application of semiconductors devices is essential for Quicker Servicing



by Ellsworth Ladyman

All electronic technicians of my acquaintance who are in charge of a repair department—either in a managerial role or as the owner—have one great common problem. This problem is *time*. Whether it is time to read about industry developments, time to check on new circuitry, or time to attend service meetings, most of us just don't have the time. I know this very well, for I have been employed in both capacities and I fully realize the time consumed in parts inventory, accounting functions, personnel supervision, etc. But if you don't find the time somewhere, you will find yourself being told about the new developments by the part-time high school boy who comes in to sweep the floor.

This article is designed to furnish a ready reference to circuit operations for some everyday solid-state devices. You are working with these items every day and are probably completely aware of the "cause and effect" operations, but maybe you're not quite as familiar with the actual operations. *Cause and effect* means you know exactly what happens when a specific unit shorts, opens, or changes in some manner. *Actual operation,* on the other hand, means what it is doing when everything is going great.

Thermistors

For several years now, thermistors have been widely used. A thermistor is a resistor with a negative temperature coefficient. That is, as the thermistor is heated by circuit action (current flow), the value of resistance decreases. The more familiar carbon resistors have a positive temperature coefficient; as they heat up, they tend to increase in resistance.

Themistors are actually semiconductors doped to provide a specific resistance. Their main function is to provide a means of stabilizing transistor circuits, since transistors are particularly susceptible to variations in temperature. Fig. 1 illustrates a practical function of a thermistor: temperature compensation for a Class B, push-pull amplifier circuit. Operation is as follows:

1. Forward biasing for the push-pull PNP transistors is provided by the voltage drop across the thermistor.
2. The current flowing through the thermistor will be comparatively constant due to the relatively high series resistance of the circuit.
3. The forward bias, or voltage drop, is proportional to the resistance of the thermistor.
4. An increase in temperature causes a decrease in resistance, lowering the voltage drop across the thermistor and effectively decreasing the bias voltage to the transistors.
5. The fixed resistor shunting the thermistor prevents a rapid change in biasing.

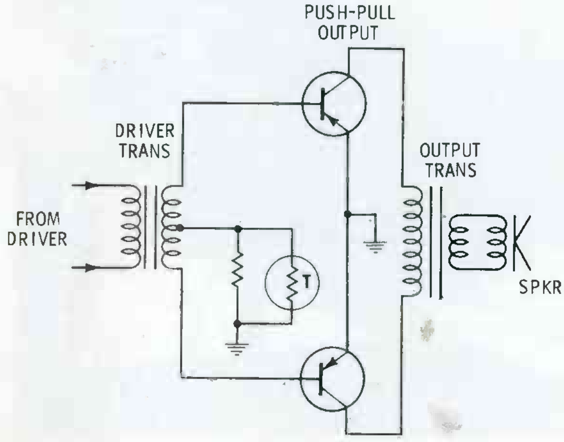


Fig. 1. Thermistor regulates base bias.

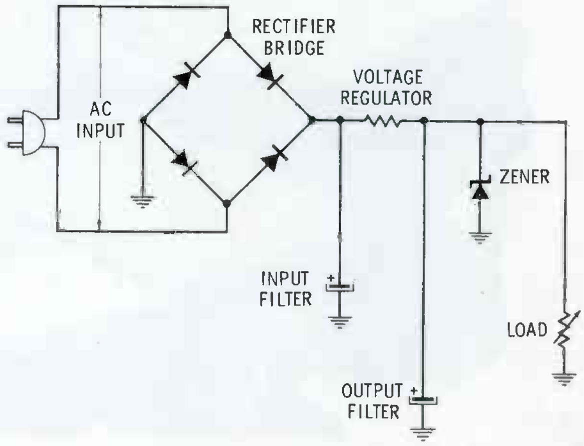


Fig. 2. Typical Zener-regulated supply.

Zener Diodes

Another very useful and versatile solid-state device to come on the scene within the last few years is the Zener Diode. The properties of this device make it very convenient for many applications. For years it was known that when a diode is reverse-biased by a voltage of sufficient magnitude, a point of "breakdown" is attained. This event will damage or ruin conventional diodes, but Zener diodes are designed to consistently withstand the breakdown. This characteristic has advantages that lend themselves to a variety of circuit configurations.

One such configuration is shown is shown in Fig. 2. A Zener connected in this manner renders a power supply practically independent of input voltage fluctuations or changing external load conditions. An added feature of a Zener-regulated supply is that ripple content of the output voltage is substantially less compared to conventional filtering. The circuit action of a Zener is as follows:

1. When the Zener is reverse-biased by a signal exceeding the breakdown point, a very small change in reverse voltage produces a large change in reverse current.
2. This means that at the breakdown point, the voltage across the diode is virtually unaffected by the current through it.
3. A zener diode will react to forward biasing just as a normal diode does.

Zener diodes have many applications and are being used extensively in such sophisticated equipment as computers, test equipment, dictation machines, etc.

Silicon Controlled Rectifiers

The Silicon Controlled Rectifier (SCR) is not, in the strictest terminology, either a diode or a transistor. It is actually a four-layer device (See Fig. 3A) that acts as two transistors connected as shown in Fig. 3B, but in circuit applications performs more in the manner of a diode. Operation of the SCR is as follows:

1. The collector of the NPN section drives the base of the PNP section. The output of the PNP section is applied to the base of the NPN section; the gate lead is connected at this junction.
2. This configuration forms a positive feedback loop with a gain equal to the product of Q1 gain (Beta 1) and Q2 gain (Beta 2). When the total gain (B1 × B2) is less than 1, the circuit will remain stable, but when the gain equals unity or greater, the circuit will become regenerative and heavy current will flow.

For example:

1. A small negative signal applied to the gate will bias the NPN section (Q1) into cutoff, so the loop gain will equal less than 1. The only current flowing in the circuit under these conditions will be the extremely small collector cutoff (leakage) current. The impedance existing between anode and cathode will approach an "open circuit" value.
2. Application of a positive signal to the gate biases Q1 into conduction; its collector current increases and is applied to the base of Q2. The current gain, or Beta, of Q2 increases with an increase in Q1 collector current, and when the current gain reaches unity, or 1, the circuit becomes regenerative.
3. The collector current of both sections rapidly increases, being limited only by the demands of the external loading circuit (and the capacity of the SCR).
4. The positive triggering signal is no longer required. As long as the loading demands exceed the current amplitude required to sustain regeneration, the SCR will conduct.
5. In this manner an SCR can switch several hundred amperes from a very small triggering current.

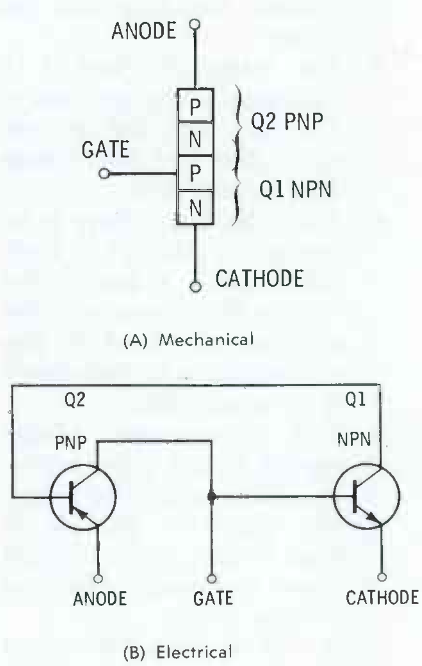


Fig. 3. Construction of an SCR.

An SCR has the unique ability to change from effectively an open circuit to an effectively short circuit by the application of proper signal currents between the gate and cathode. Once conduction is established, the only way to turn it off is to reduce the load current below the regenerative requirements. Triggering current is required only until regeneration is reached—approximately 5 microseconds for resistive loads.

Analogous to the SCR is the Thyratron tube, a gas-filled controlled rectifier. The thyratron compares to an SCR in that it too can not be controlled by the input signal once it fires. Obviously, an SCR has many advantages over the thyratron, such as:

1. Filament voltage is not required.
2. No warm-up time.
3. No damage should the load be applied before regeneration is attained.
4. Efficiency.
5. Cost.
6. Ease of construction.

Silicon controlled rectifiers have a wide range of applications, and more are being found everyday. It is basically a very efficient switching device. Computers, recorders, motor speed control, lighting adjustments, voice actuated relays, etc., all lend themselves to efficient use of SCR's.

Tunnel Diodes

Tunnel diodes have to fall under a "special circuits" category, at

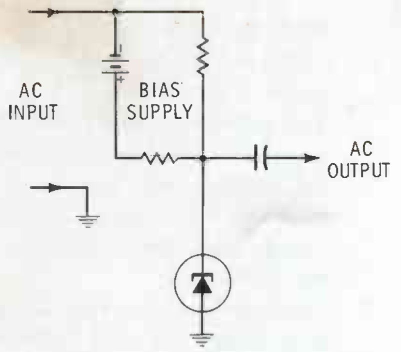


Fig. 4. Tunnel-diode amplifier.

least for the present. Physically, they look just like any other diode, but their operation is almost exactly the opposite. They are doped much more heavily than the average PN junction, and from this derive their name. A heavily doped junction results in a large amount of majority carriers, so the device needs only a small bias voltage to produce circuit action. Tunnel diodes do not have the circuit gain of transistors in the lower frequencies, but in the higher frequencies (microwave band) they function extremely well.

The useful property of tunnel diodes is the negative-resistance section in their characteristic curve. The exploitation of this characteristic allows their use in amplifier applications, as follows:

1. A tunnel diode conducts in either forward or reverse direction due to the heavy doping. (A conventional diode will conduct in only one direction.)
2. Application of a small forward bias voltage results in an extremely high forward conduction rate.
3. A further increase in forward bias voltage will result in a decrease in the forward conduction rate.
4. When an increase in voltage results in a decrease in current, a negative resistance characteristic is established. (This negative resistance can not be literally termed a minus resistance; it is actually a function of the voltage variation across the diode with reference to the change in current through the diode.)
5. With a circuit configuration such as in Fig. 4, the voltage changes across the tunnel diode (produced by the negative resistance curve) will be opposite and larger than the excursions of the AC driving voltage.

Field Effect Transistors

The field effect transistor (FET) acts so much like a vacuum tube that design engineers find themselves with much latitude in circuit design. Unlike most transistors, which are current amplifying devices, FET's function as voltage amplifiers and are rated somewhat in the manner of vacuum tubes (in transconductance.) In an FET the forward transconductance for the common-source circuit configuration is the ratio of a change in drain current to the change in the gate-to-source voltage.

FET's are being used in many applications today. They lend themselves readily to meter circuitry, and modern FET meters combine the best features of both VOM's and VTVM's, without the detriments of either unit. They are compact, portable, require no warm up time, no AC connection is necessary, and their accuracy is limited only by the design cost factors. Fig. 5 shows an FET connected as a video amplifier. Circuit action of the FET is as follows:

1. A negative bias voltage is applied between the gate and the source.
2. A positive voltage is applied between the drain and the source.
3. The voltage in Step 1 is analogous to the grid bias of a vacuum tube, and the voltage in Step 2 to plate voltage of a vacuum tube.
4. When the gate voltage is increased (negatively) to a sufficient value, a point called "pinch-off" is reached, and all current flow is cut off. This is comparable to bias cut-off of a vacuum tube.
5. With proper static voltages applied to the gate, source, and drain, an increase in gate bias causes a decrease in drain current, and a decrease in gate bias causes in increase in drain current.
6. Due to the reverse biasing of the gate junction, gate current is at a minimum, allowing high input resistance characteristics.

Voltage and Temperature Dependent Resistors

Automatic degaussing circuits utilize the negative and/or positive temperature coefficient characteristics of doped resistors. In Fig. 6, R216 is a thermistor or temperature dependent resistor, and R215 is a voltage dependent resistor (VDR). At room temperature (cold) the value of R216 is 120 ohms. With zero voltage applied, the resistance of R216 is negligible. When the switch is closed, power is applied to the primary winding of the power transformer. Most of the AC current induced in the secondary winding flows through the very low resistance of R215 and the degaussing coil. This current sets up an AC magnetic field around the degaussing coil to provide the demagnetizing action for the picture tube and picture tube shield. The small current flowing through R216 causes it to start heating. As it increases in temperature, it decreases in resistance, and the current flow through it is therefore increased. Consequently, a lower voltage is applied across R215, and its resistance value starts increasing. This combined action, R215 increasing and R216 decreasing in resistance, results in a gradual decline in the current flow through the degaussing coils. Degaussing occurs as a result of the initial current flow through the degaussing coils. Remagnetization is prevented by the gradual reduction of current flow.

Varactors

The varactor is a two-terminal,

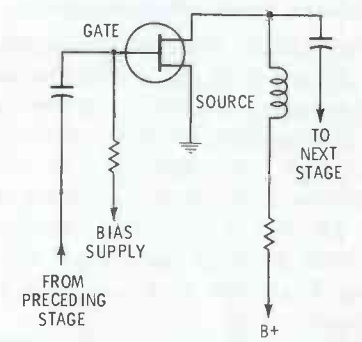


Fig. 5. FET video amplifier circuit.

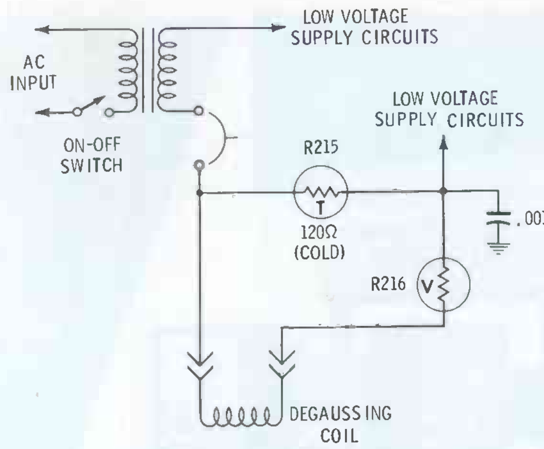


Fig. 6. Typical degaussing circuit with thermistor and VDR.

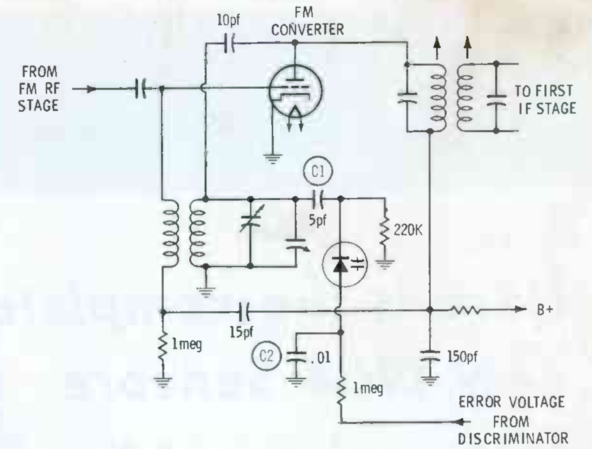


Fig. 7. AFC varactor is part of oscillator tank circuit

designed to take advantage of the capacitance effect of the depletion layer in a PN junction. Since the layer changes with the applied voltage, the capacitance will also change. Applications of varactors are many and varied, including tuning circuits, amplifiers, oscillators, frequency dividers, etc.

The illustration in Fig. 7 shows a varactor connected in the AFC circuit of an FM radio. In this circuit, the varactor acts to prevent tuner drift. This is done by correcting the oscillator frequency in accordance with the error that is developed in the discriminator.

The varactor is connected across the oscillator tank circuit through a blocking capacitor, C1. As the DC bias varies across the varactor (in accordance with the detector signal), the oscillator frequency—and therefore the receiver tuning—is varied accordingly. While the receiver stays tuned to a selected station frequency, no error signal is received by the varactor from the FM detector. If drifting occurs, an immediate correcting voltage is applied to the varactor, and the oscillator frequency changes, returning the receiver to the correct selected frequency. This description is an over-simplification of this circuit. If you would like more information on varactors, refer to the January 1968 PF Reporter. The annual index lists several articles which cover the subject extremely well. ▲

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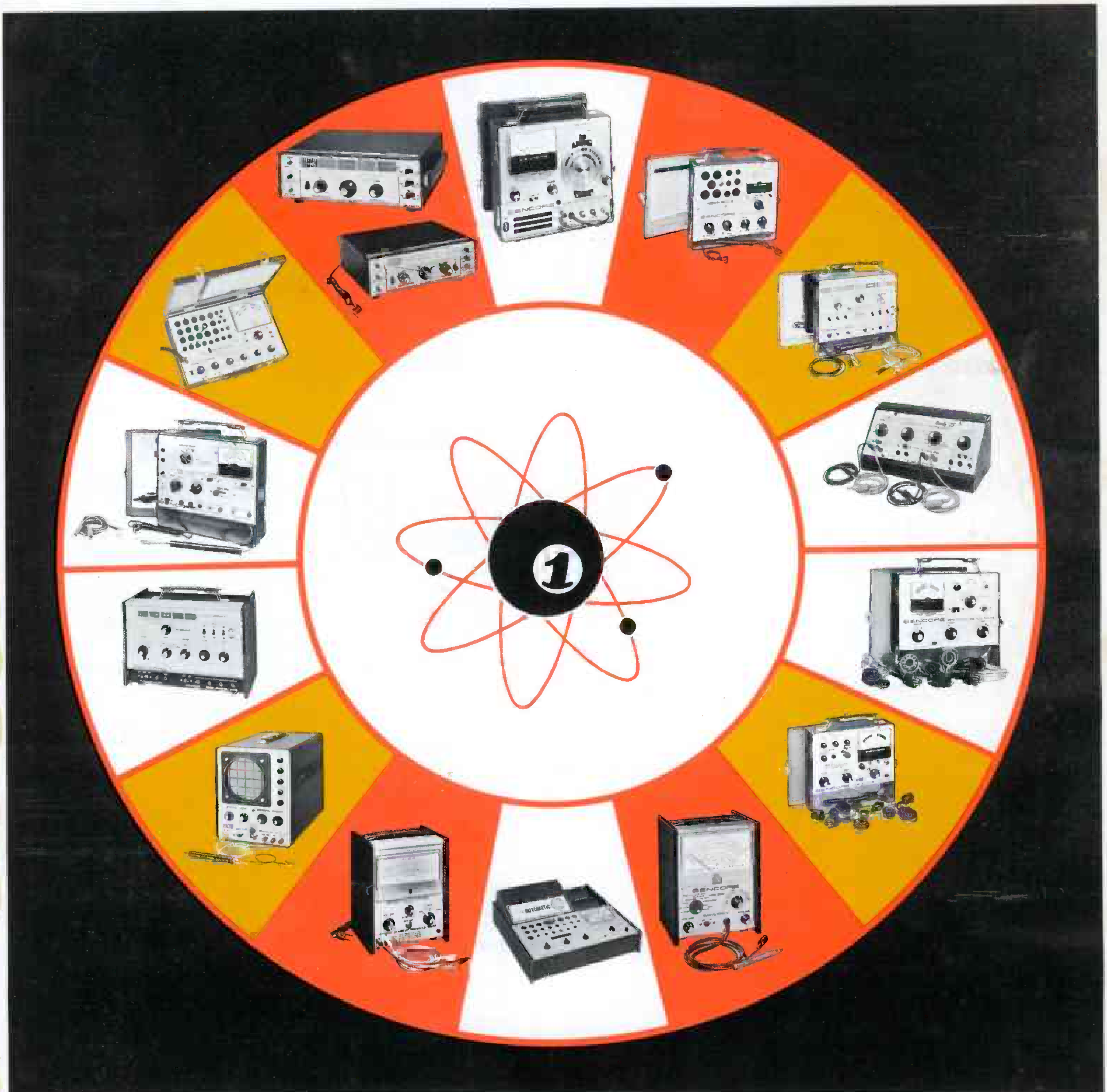

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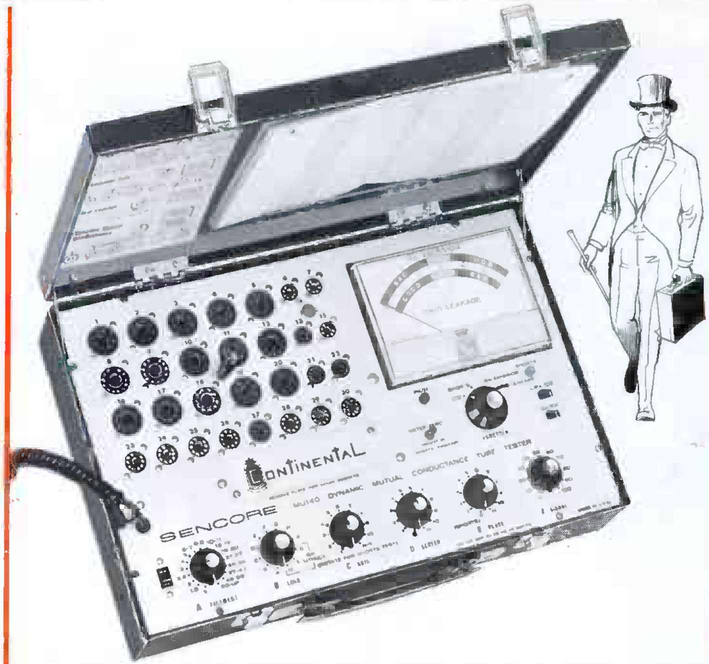

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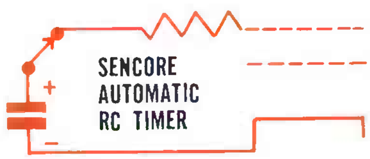

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A DELUXE CRT TESTER THAT MAKES EVERY TEST ACCORDING TO INDUSTRY STANDARDS. The CRT Champion is a must for accurate testing of color guns for tracking at all settings of the TV brightness control. A truly fine tester that works as well for checking black and white tubes. Now, for the first time, CRT manufacturers' testing recommendations can be followed to the letter; and without the need of time consuming charts or logging of comparison readings. It is all done automatically in the CRT Champion. Separate screen grid controls are provided for each color gun so that each gun can be set up just like in the color receiver. Then, each gun can carefully be compared to the other for tracking. This check is extremely important when it comes to claiming credit on a defective color CRT from the manufacturer.

The Champion has all of the standard tests too, such as shorts test, emission test with pure DC, and life test. It is much easier to use than you might imagine.

Rejuvenation and shorts removal is accomplished with the exclusive Automatic Controlled Rejuvenation circuit just like in the CR13 Cadet. Three rejuvenation positions insure the user that he can go to any length to save a faulty tube or equalize gun currents in color tubes. Line adjust control provided is essential when checking critical tubes where line voltage fluctuations might cause improper readings.

Equipped with plug-in sockets for fast testing and easy updating. Controls, calibrated in actual DC volts, are so standard that they can be set from any CRT manual if the need should arise. Housed in chrome panel and rugged all steel vinyl case with spacious lead compartment. 10" x 9" x 3½" 11 lbs.

$99.50

CG141 COLOR KING

NEW

THE KING OF ALL COLOR GENERATORS

Here is truly the finest Standard color bar generator modern technology and design methods can produce. At long last a generator that can be completely relied upon for functional design and absolute stability. Patterns will remain rock solid at any temperature. Compare these features with any generator in any price range.

- **Temperature controlled Circuits:** No more worry about pattern instability in cold weather or on hot days. Sencore's new "Temp Control" maintains a thermostatically controlled temperature above 80 degrees even on the coldest days. New silicon timers specially designed for hot weather maintain complete stability to 140 degrees Fahrenheit. A Sencore exclusive.
- **TWO new color patterns:** The Color King has all five standard patterns plus two NEW patterns; a single dot and a single cross. The dot and cross can be centered or moved to any spot on the screen, simplifying both static and dynamic convergence. A Sencore exclusive.
- **NEW Snap Tuning for channels 2 through 6.** Eliminates troublesome tuning between channels and co-channel interference. It's just like tuning in a channel on your TV.
- **Interlace.** A patent pending interlace control to stop dot bounce found on some sets. Forms a perfectly round dot.
- **New Analyzing features:** Increased output of composite chroma (±7VPP) and Sync signals (—5VPP) for new TV sets makes the job of tying down Chroma troubles a snap.
- **Standard color bars** . . . RCA licensed standard color bars, 14 horizontal lines, 10 vertical lines, crosshatch, adjustable white dots, and an individual movable single dot and single cross. Complete convenience.
- **Crystal controlled sound carrier** 4.5 megahertz for adjusting fine tuning according to manufacturer recommendations.
- **Color gun interrupters** . . . with switches on the front panel. Resistors in lead piercing clips eliminate picture smearing found on other generators.
- **Solid state** . . . AC operated and solid state throughout. Zener regulated power supply for added stability and solid patterns.
- **No internal adjustments.** All adjustments are located on the front panel under the hinged pattern strip. You never have to tear your generator apart to make a simple touch up adjustment. Three timer controls, 5 fine tuning trimmers, one for each channel, and a dot size adjustment. Sencore exclusive.
- **All steel vinyl covered case** with removable protective lid. High quality shock mounted plate glass mirror in lid for convenient setup and convergence in the home.

You must agree that the Sencore Color King has everything. Yet it's priced as much as $20.00 under other generators that offer far less. 10" x 9" x 3½", 9 lbs.

$149.95

COLOR GENERATORS

CG10 - CG12 LO-BOY

CG10

CG12

LO-BOY STANDARD COLOR BAR GENERATORS

You expect more from SENCORE—and the LO-BOY proves you get it. Feature for feature, dollar for dollar, it's far and away your best buy in color generators.

COLOR BARS. Ten standard RCA licensed color bar patterns; NTSC phased colors.

PATTERNS. Crosshatch, vertical lines, horizontal lines, adjustable white dots—all the patterns found on generators costing as much as $100 more. All at the flick of a switch. No lines missing on crosshatch—14 horizontal and 10 vertical.

INTERLACE CONTROL. A Sencore "first." Stops dot bounce that varies from set to set.

COUNTING CIRCUITS. All new, Patent pending, using new silicon transistors that perform up to 140°. Crystal controlled timers for the utmost in stability.

TIMER CONTROLS. Right on the front panel, within easy reach. As easy to adjust as the horizontal and vertical hold controls on a TV set, if the timers should ever jump. Absolutely eliminates timer instability.

ALL SOLID STATE. Low warm-up time, provides all patterns instantly.

CONSTRUCTION. Tough, scuff-resistant vinyl-clad steel that can "really take it;" stays new looking longer. Compact—hardly bigger than a cigar box. Easy to carry from job to job.

SENCORE CG10. New zener regulated battery power with long-life "C" cells. The 12 volt battery supply can wear down to nearly 9 volts without affecting the circuits. New leakproof battery holders permit easy replacement without dismantling the unit.

Priced at less than the cost of a kit,

$89.95

SENCORE CG12. AC operated with a zener regulated power supply for added stability even with line voltage variations. Has 4.5 MHZ crystal controlled signal for fine tuning as recommended by color TV manufacturers.................only

10″ x 8⅜″ x 3⅛″ 8 lbs.

$109.95

CA122B ANALYZER

Here is a complete comprehensive analyzer for color and black and white servicing. The CA122B is a complete standard color bar generator as well. Its outstanding features place it in a class by itself. You get a combination value of analyzer and color bar generator for the price of a generator alone.

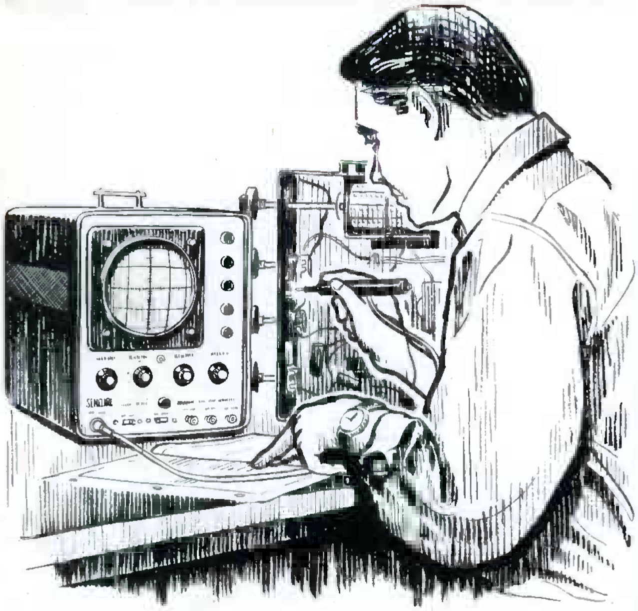
- **Complete convergence patterns.** Standard RCA licensed color bars, 10 vertical lines, 14 horizontal lines, crosshatch, adjustable white dots, and a no modulation position for purity and gray scale tracking adjustments. Complete in every way.
- **Pinpoint problems by signal injection.** Variable RF output Ch. 2, 3, 4, 5, 6 for pattern injection into the antenna terminals. Variable IF output 20MHz to 50MHz . . . for tuner substitution or injection directly into any IF stage; quickly locates defective or low gain IF stages. Composite Video, Chroma, and horizontal and vertical sync pulses all continuously variable both positive and negative up to 30 volts peak to peak; for trouble shooting any of these stages by simple signal substitution.
- **4.5 MHz crystal output** insures accurate fine tuning. Also used to trouble shoot sound problems in sound IF circuits . . . 900 Hertz audio signal for injection into any audio stage up to the speaker.
- **Color gun interrupters;** switches on the front panel use lead piercing clips with isolating resistors in the clip to prevent picture smear.
- **Vacuum tube operated** for proper impedance match when injecting signals into high impedance circuits. AC operated, the CA122B is a proven workhorse. A complete analyzer yet portable enough for use on service calls.

Handsome all steel case and chrome panel with large lead compartment features functional, modern styling. 10″ x 14″ x 8″, 15 lbs.

$187.50

PS127 PROFESSIONAL 5 INCH SCOPE

PS148 DELU



39G3 DEMODULATOR PROBE! FOR PS127 & PS148

- WIDE BAND, HIGH SENSITIVITY
- DIRECT PEAK TO PEAK VOLTAGE MEASUREMENTS
- HALF MEGAHERTZ HORIZONTAL SWEEP
- BUILT-IN LOCAP AND HI VOLTAGE PROBE

The many exclusive features place this scope in a class by itself. Portable and smartly styled, this oscilloscope equips you for every servicing job; outstanding flexibility makes it ideal for field engineering and production line testing and many other applications where ease of operation and healthy specifications are desired. The Sencore PS127 compares to other scopes costing much more for comparable features and performance.

Direct vertical peak to peak voltage readout that is always accurate. Voltages are read right off the front panel. No need to feed in confusing calibration signals and interpolate readings. Measure exactly any voltage on display with no confusing bandswitching. It is even faster than using a VTVM.

Wide Band. Vertical amplifier frequency response from 10 Hz to 5.2 megahertz, ±1DB. Rise time of .055 microseconds. This extra response insures true waveform reproduction of complex signals.

High Sensitivity . . . Vertical amplifier sensitivity of .017 volts rms per inch deflection. Great for transistor work and to read low level signals such as directly from the tuner in a TV receiver.

Extended Horizontal sweep frequencies . . . Horizontal sweep ranges 5 Hertz to 500KHz in five overlapping ranges. TV horizontal and vertical sweep frequencies preset on coarse control.

Positive Sync . . . outstanding stability is due to precise control over sync signals. Variable control enables operator to lock in complex waveforms almost as easily as triggered sweep types.

High input impedance . . . Minimum circuit loading is assured with input Z of 27 megohms shunted by 9pf using built-in lo capacity probe. Direct probe Z of 2.7 megohms shunted by 99pf.

Five Kilovolt hi voltage rating in built-in low capacity probe to view waveforms in TV horizontal and vertical output circuits.

Horizontal frequency response (3DB, from 10 Hertz to 650 KHz) guarantees linear sweep and positive sync.

External inputs for horizontal sweep and external sync on front panel. With provisions for intensity modulation and direct connection to deflection plates on rear of instrument.

Retrace blanking . . . Horizontal retrace is built in and effective on all of the horizontal sweep ranges.

Standby switch. Cuts to half power when unit is not in use and provides instant warm-up when needed.

All steel case with beautiful brushed chrome front panel, the Sencore PS127 is as handsome as it is functional.

11" x 9" x 15½", 22 lbs., 100 watts, 60 cycle, AC, 47 watts on standby.

39G3 Demodulator probe $5.75

PS127

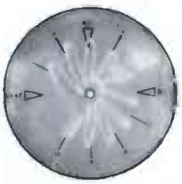
$199.50

DE BAND SCOPE AND VECTORSCOPE

NOW — YOU CAN HAVE BOTH IN ONE INSTRUMENT:
- **A CONVENTIONAL WIDE BAND OSCILLOSCOPE**
- **A PROFESSIONAL 5-INCH VECTORSCOPE**

The PS148 wide band scope is identical in features and specifications to the PS127. In addition, it provides a vectorscope for complete simplified troubleshooting and alignment of color TV chroma circuits. Now, you can view the vector patterns as recommended by Zenith or display the standard "S" pattern as recommended by RCA. Both methods are at your fingertips with the PS148. Now, for only $20.00 more than the PS127, you can view vectors and still own a deluxe wide band scope for all other work. Why pay many times more?

- Converts at the flick of a switch on rear panel from a professional wide band scope to a large 5-inch vectorscope. All vectorscope connections and controls are located on rear for ease of operation and to prevent color demodulator circuit loading.
- Simplified instructions for using the vectorscope in color TV chroma circuits and for troubleshooting and alignment are packed with each instrument.
- Comes with special vectorgraph screen which shows exact degree of chroma demodulation; also includes viewing hood.
- Use with any standard 10 bar color generator, such as all Sencore, RCA, etc. Use your present color generator and save money.
- Vectorscope connections on PS148 rear also speeds up other work where direct connections to the CRT deflection plates are required; such as, modulation checks and lissajous patterns for communications or lab work.



VECTORSCOPE PATTERN

PS148

$219.50

39G3 Demodulator probe $5.75

FM MULTIPLEX

STANDARD MULTIPLEX GENERATOR AND ANALYZER

MX129 ANALYZER. An all-transistor portable FM stereo generator–provides all signals generated from the FM transmitter. Crystal controlled. As an analyzer, operating controls provide full control over left and right signals, pilot signal and modulating signals. Stereo signals are formed from internal 1000 or 60 hertz, or from external generator, mike or phono pickup. Exclusive built-in meter, calibrated in DB and PP volts, for balancing left and right signals. Also serves as an external meter to connect across the speakers for channel separation checks. RF, pre-set at 100mc at factory, can be adjusted to any point on the FM band from front of unit. Composite stereo signal for injection at the stereo adaptor for trouble shooting or as a check on RF and IF alignment. 67 HZ subscription signal provided on carrier, or unmodulated for trap alignment. All steel case with detachable protective cover. 10" x 9" x 3½", 9 pounds.

MX129
$199.50

MX11 CHANNELIZER. So simple to operate, you need no other instruments. Just hook up the RF output cable to the receiver antenna terminals; connect the two speaker leads in place of the speakers; then read the channel separation directly on the meters, calibrated in DB and as LOW, GOOD and HI. Meters have built-in 8 ohm loads to substitute directly for removed speakers. Flick the left channel switch "on" and you have left channel output; now flip on the right channel switch and you have both. Pilot signal can be turned off or to 5 or 10 per cent as required. Composite stereo signal (no RF) available for injection directly into multiplex adaptor. All solid state circuitry—crystal controlled—battery operated. Includes all leads. 10" x 8⅜" x 3⅛", 6 lbs.

MX11
$99.50

CHANNELIZER

SM112B SERVICEMASTER

EXCLUSIVE

2 IN 1

VTVM & VOM

COMBINATION

Accurate enough for the laboratory and yet the ideal meter for the serviceman or man on the go. It's a standard VTVM but a battery operated VOM at the flick of a switch.

SIMPLE: Just one function switch, one range switch, and one probe for all functions of VTVM and VOM.

Voltage, current and resistance in 33 ranges—for accurate, dependable measurements anywhere, any time.

VTVM operates from 115v ac. Lighted arrows on the VTVM scales automatically indicate the exact scale to read.

VOM gives you a portable 5000 ohms per volt meter for use where power is not available.

Large, easy-to-read 6 inch two percent meter covers all measurements.

VTVM SPECIFICATIONS

VTVM DC VOLTS . . .

Ranges: 0 to 3, 10, 30, 100, 300, 1000, full scale.
Input resistance: 11 megohms.
Accuracy: ± 3% full scale.

VTVM AC VOLTS

Ranges: (RMS) 0 to 3, 10, 30, 100, 300, 1000 full scale.
Frequency Response: 30 HZ to 4.5 MHZ on first four ranges.
Accuracy: ± 5% full scale.
Peak to peak ranges: 0 to 8.4PP, 28PP, 84PP, 280PP, 840PP, 2800PP.

VTVM OHMMETER

Ranges: 0 to 1K, 10K, 100K, and 0 to 1,10 and 1000 megohms.

VOM SPECIFICATIONS

VOM CURRENT:

1 range 0 to 1 amp.

VOM DC VOLTS

Ranges: 0 to 3, 10, 30, 100, 300, 1000.
Sensitivity: 5,000 ohms per volt.
Accuracy: ±3% full scale.

VOM AC VOLTS

Ranges: 0 to 3, 10, 30, 100, 300, 1000.
Sensitivity: 500 ohms per volt.
Accuracy: ±5% full scale.

VOM OHMMETER

Ranges: 0 to 10,000 oms; 0 to 1 megohm.

Professional quality through and through . . . New bench styling in rugged vinyl-clad steel case. Cabinet 9" x 7½" x 6", with brushed chrome panel. Weight 6 lbs.

$89.95

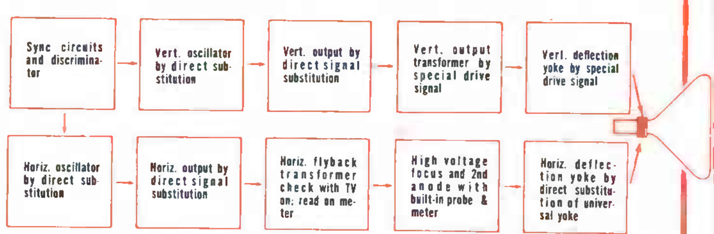
Hi Voltage Probe HP118 for SM112, SM112A, SM112B **$9.95**

SS137 COMPLETE SWEEP CIRCUIT ANALYZER

Everything you need to isolate ANY sweep circuit troubles in seconds and eliminate all guesswork.

Simplifies Sweep circuit trouble-shooting in all Color or Black and White receivers. Uses positive, tried and proven signal injection and component substitution to find the tough sweep circuit problems. All tests dynamic, in circuit, with the TV set on.

Checks all sweep circuit functions shown in block diagram.



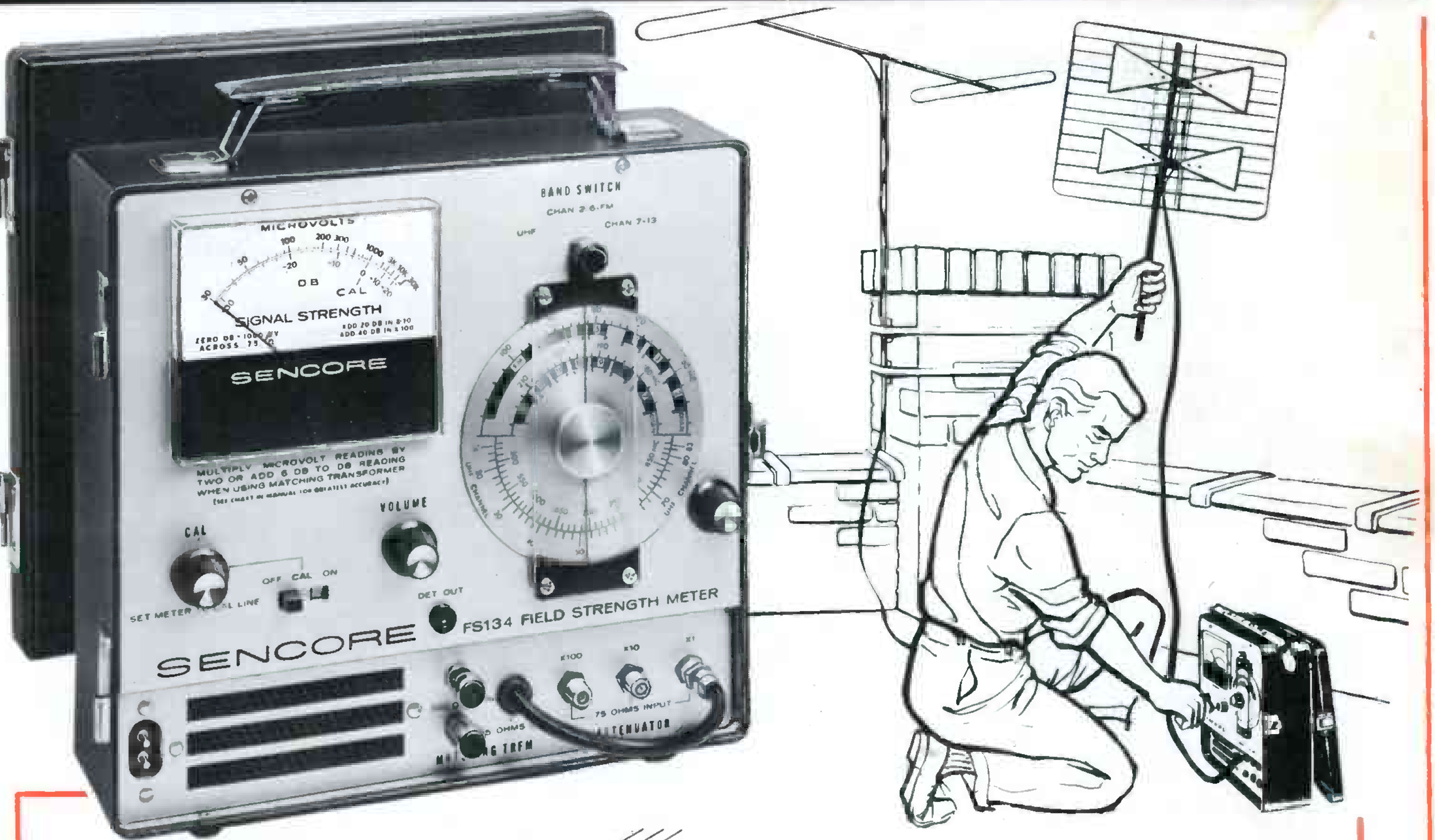
External checks with built-in VTVM: No need to hunt for a second meter while checking out the sweep circuits; DC volts from 0 to 1000 volts, AC volts peak to peak from 0 to 1000 volts, and 2nd anode voltage measurements of 10KV and 30KV. Current scale of 300 Ma for checking fuse current and output tube cathode current; special 3 Ma range for setting high voltage regulator current in Color TV.

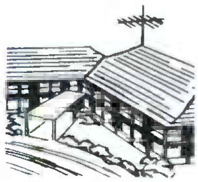
Housed in all steel case with shock mounted high quality plate glass mirror in detachable hinged cover. 10" x 9" x 3½", 10 lbs.

$94.50

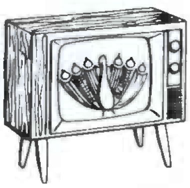
FIELD STRENGTH METER

FS134 UHF-VHF-FM SOLID STATE FIELD STRENGTH METER

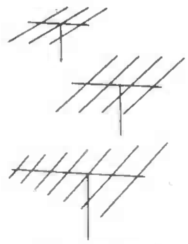




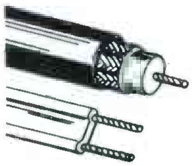
CHECK DISTRIBUTION SYSTEMS



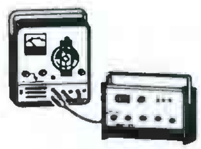
COLOR INSURANCE



MAKE ANTENNA COMPARISON



MEASURE DROP IN TRANSMISSION LINES



CHECK SIGNAL GENERATORS

Get in on the lucrative business in distribution systems, UHF, FM, and VHF antenna jobs with the all new FS134 completely solid state portable field strength meter. Calibrated in true microvolts on all bands: ±3DB on VHF-FM/±6DB on UHF.

FS134 Field Strength Meter—The FS134 uses Jerrold coax connectors so you can correct problems on existing systems, as well as install, balance, and check new distribution systems. Built-in attenuators of 0, 20, and 40 db (X1, X10, and X100) enable you to measure signal strength from the amplifier to the last tap-off in the system. The FS134 is portable and requires no AC cord; you can take it to the top of the tower to orient the VHF TV, UHF TV, and FM antennas for best signal with minimum interaction between them. Highly sensitive: 30 Microvolts ±3DB on VHF-FM and 30 Microvolts ±6DB UHF. Separate built-in UHF tuner for greater accuracy in critical antenna work and translator checking. 4" 2% meter calibrated in microvolts and db. Uses industrial standard for 0 db, often called 0 DBJ or DBM.

Now check db loss in various cables and lines, compare different antennas and amplifiers for db gain, field intensity surveys, and show a critical customer why he needs a new antenna for his FM stereo or color TV set. The audio amplifier and speaker let you monitor the TV or FM sound signal and aid in tracking down noise. Besides the Jerrold connector for 75 ohm cable, the FS134 has a built-in balun to match 300 ohm twin-lead; no messy adaptors. The FS134 is powered by easy to get "C" cells or optional rechargeable battery supply (part #39G15), installed in minutes as cheater cord receptacle is already riveted to panel. 10" x 9" x 5", 9 lbs.

$199.50

39G15 Rechargeable battery supply (less battery) $9.95

TR139 · TR15A IN-CIRCUIT TRANSISTOR TESTERS

NEW

TR139

TR15A

THE TRANSISTOR TESTERS THAT REALLY WORK IN CIRCUIT

Locate defective transistors in circuit in seconds with a true AC signal gain test (BETA) . . . without disconnecting a single lead . . . what a time saver. Also measure AC beta and Icbo leakage out of circuit for complete analysis of the transistor. It's easy, fast and accurate. Also checks diodes and rectifiers in and out of circuit.

TRUE BETA MEASUREMENTS: the transistor's AC gain factor. Set the CAL knob, press the beta test button and read the actual AC gain on the meter. This is the ratio of AC signal on the base of the transistor to that obtained on the collector and is a standard of measurement in the industry.

Icbo LEAKAGE MEASUREMENTS. An important check since many transistors have good beta but don't work because the leakage current has become too high. Both instruments show the leakage current (Icbo) in microamps right on the meter.

OUT-OF-CIRCUIT TESTS. Test procedure is the same for in or out-of-circuit testing. Out of circuit, transistors may be sorted, selected and matched for specified values of beta and Icbo.

COMPLETE PROTECTION. Special circuitry protects even the most delicate transistors and diodes, even if the leads are connected incorrectly. No possibility of damage to the transistor, circuit or instrument. Zener regulated power supply.

NO SET-UP BOOK. No need for a set-up book or manual. Just refer to the handy transistor checking guide on the back of the instrument. Even unknown transistors can be checked. PNP and NPN types can be determined at the flick of a switch.

ALL STEEL CASE. Vinyl covered, with brushed chrome panel. Beta range, 2 to infinity; Icbo, 0 to 5000 microamps.

DELUXE TR139. "Howard W. Sams" transistor manual included for beta and Icbo reference. 9" x 7½" x 6", with large 6" meter, 8 lbs. **$89.50**

COMPACT TR15A. Only 5" x 7-3/16" x 3-1/16"—just right for easy handling. Easy-to-read 4½" meter. 4½ lbs. **$64.50**

TR115 TRANSISTOR-DIODE CHECKER

Tests transistors for leakage, gain, opens and shorts (out of circuit only)—good, bad or directly in DC beta; checks diodes for forward to reverse ratio. From smallest hearing aid transistors to auto radio power types. Simply operated, proven checker can be used without set up chart for service and experiments.

5" x 4½" x 2½". 2 lbs. **$24.95**

BE124 BATTERY ELIMINATOR

Power supply replaces batteries during transistor radio repair. Tapped voltages at 1.5 volt DC intervals from 0 to 12 volts on front panel, connects simply for center tap and bias voltages as required. Function switch converts meter to trouble-shooting 0 to 50 Ma current reading device to monitor transistor radio current drain. Charges nickel-cadmium batteries.

Guaranteed accurate. 5" x 4½" x 2½", 3 lbs. **$29.95**

RC145 HANDY "53"

NEW

8¼" x 4¾" x 4¾", 3 lbs.

Fifty three frequently used values of resistors, capacitors and dual or single electrolytics. Twelve 1 watt resistors from 10 to 5.6k ohms. 12 ½-watt resistors from 10k to 5.6 megohms. Ten 600-volt capacitors from 100mmfd to .5 mfd. Ten electrolytics that can be used as duals or singly to form up to 25 different values. Exclusive electrolytic surge protector circuit prevents arc, spark or healing of electrolytic in set; 2mfd to 250mfd at 450 volts.

$34.95

RC146 HANDY "75"

NEW

Seventy five frequently used values of carbon resistors, capacitors, electrolytics, power resistors and universal selenium and silicon rectifiers for fast on the spot substitution. Resistor, capacitor and electrolytic line up is exactly same as RC145. Power resistors of 20 watts from 2.5 to 15,000 ohms and a universal .5 amp silicon and selenium rectifier makes the RC146 truly deluxe for parts substitution.
10¼" x 4¾" x 4¾", 3½ lbs.

All Sencore substitution units sell for less than the cost of the parts alone.

$44.95

TC131 TUBE TESTER

The "Counter/Bench" version of the famous Mighty Mite Tester shown on page 2, designed for two-way use—as a professional shop tester and customer self-service unit. Semi-automatic; simply turn function control to any test and watch lighted arrow on big, 6-inch meter stop on right scale—user can't go wrong, no neon lights or guesswork—everything is read on meter. Only 3 set-up controls. A money-making traffic-builder.

Fits standard 24-inch counter. 21" x 22" x 4½", 20 pounds.

$99.95

11

RC144 HANDY "36"

NEW

36 different, most often needed resistors and capacitors for experimenting, substituting and testing—24-½ and 1 watt resistors from 10 ohms to 5.6 megohms, 10 capacitors from 100mmfd to .5 mfd, at 600 volts. 2 electrolytics at 10 mfd and 40 mfd at 450 volts DC. 4" x 3" x 2". 2 lbs.

$14.95

FC147 FILAMENT CHECKER

NEW

Check continuity of all tube filaments including the new Compactrons, Novars, 10-pins, Nuvistors and the new Decals. Test leads for CRT filament checking. Also, doubles as neon voltage indicator. TV cheater cord is used to power unit as a check on the cord to insure 115 volts AC on TV. 4" x 3" x 1". 1 pound.

$4.95

BE113 DUAL TV BIAS SUPPLY

Save time in AGC trouble shooting and TV alignment. A single or two separate 0 to 20 volts DC bias supplies—without interaction. Provides all recommended TV alignment biases. Well filtered; effectively pure DC with less than 1/10th of 1% ripple—calibration accuracy better than equivalent battery tolerance.
4" x 3" x 2", 1 pound.

$14.95

FE14 FIELD EFFECT VOLT-OHM-MILLIAMETER

Revolutionary New Concept in Voltage, Current and Resistance Measurements

All the advantages of a VTVM with instant warm up; made possible by use of the newly developed field effect transistor which is even superior to a vacuum tube in loading characteristics.

Minimum circuit loading. 15 megohm input resistance on DC and 10 megohm input impedance on AC—means you can measure voltages accurately with minimum load. **Mirrored scale** and full meter and circuit protection. **Zero center scale** of 0.5 V is ideal for checking transistor circuits. **Peak to peak scales** with frequency response to 10MHz. **Solid state, battery operated** for use anywhere, anytime. **Low current drain** on batteries—less than 2 ma. **Built-in battery** check assures top performance always. **All-steel case**—vinyl-clad, non-breakable.

SPECIFICATIONS

DC VOLTS

Ranges: 0 to 1, 3, 10, 30, 100, 300 and 1000 full scale. ± .5, 1.5, 5, 15, 50, 150, and 500 zero center scales.
Input Resistance: 15 megohms shunted by 14PF. Accuracy: ±3% full scale.

AC VOLTS

Ranges: (Rms): 0 to 1, 3, 10, 30, 100, 300 and 1000 full scale.
Ranges: (Peak to Peak) 0-2.8, 8.4, 28, 84, 280, 840 and 2800 full scale, frequency compensated.
Input Resistance: 10 megohms shunted by 29PF.
Frequency Response: 10Hz to 10 MHz. Accuracy: ±5% full scale.

OHMMETER

Ranges: 0 to 1000, 10K, 100K ohms, 10 and 1000 megohms. Accuracy: ±3% linear arc

DC CURRENT MEASUREMENTS

Ranges: 0 to 100 microamps, 1ma, 10ma, 100ma and 1 ampere. Accuracy: ±3% full scale.

GENERAL

Meter: 4½", 100 microamp ±2%, diode protected and isolated from input.
Ohms Battery: 1.5V "C" cell
Power Supply Battery: 9 volt, Eveready Type #222
Weight: 4 lbs. Dimensions: 5"w x 7-3/16"h x 3-1/16"d
Accessories: High Voltage Probe (39A19) extends 300 volt range to 30KV (Not Supplied)

Hi Voltage probe 39A19 — $9.95

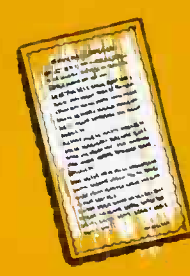
only $59.95 with test leads (less batteries)

QUALITY FEATURES OF EVERY SENCORE INSTRUMENT

STRENGTH & PORTABILITY . . . All Sencore instruments are steel encased to insure rugged service and long life. In the shop, in the truck or in the field, Sencore instruments are built to give you reliable service longer.

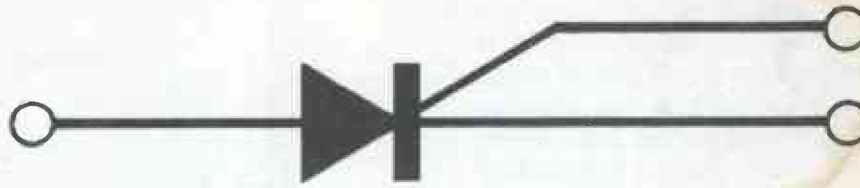
COMPLETE OPERATING INSTRUCTIONS . . . Clearly written, detailed operating instructions are included with every Sencore instrument, along with complete Circuit Schematics and parts list. Tube and other setup charts are automatically mailed to you from the factory by merely signing and returning the warranty card.

ASSURED QUALITY . . . Assured Quality has made American produced Sencore instruments the first choice of professional servicemen. At Sencore, every unit is inspected twice for over-all quality, then subjected to an extreme continuous 24 hour performance reliability test, followed by rigorous tests for stability and proper calibration under all operating conditions.



FULLY GUARANTEED . . . Sencor products are guaranteed to be free from defects due to workmanship or component failure. Except for misuse, abuse, or damage through mishandling, any ur found defective within 90 days a returned to the factory service d partment will be repaired witho charge, provided the Warranty Ca has been returned within 10 day of purchase. A modest servic charge is made for parts and/o labor in all other cases.

The SCR



As A Horizontal Gate Control Switch

Technically labeled a four-layer diode, the design of the SCR resembles two transistors, while the operation is similar to the thyratron

by Robert Middleton

A silicon-controlled rectifier (SCR) is a semiconductor rectifier. It operates as a static latching switch with a very fast response (in the order of microseconds). The SCR also operates as a switching amplifier. In this respect, it can be compared with a thyratron tube. As a latching switch, the SCR can be turned on by a momentary aplication of control current to the gate (see Fig. 1). This control pulse may have a width that is only a fraction of a microsecond. In turn, the SCR latches into conduction, much as a thyratron does when the grid is triggered into firing the tube. That is, the control pulse can only trigger the device into conduction. After conduction starts, the control pulse has no effect on device operation. The rise time of the output waveform for a typical SCR is 1 microsecond; the fall time is 10 microseconds. To return an SCR to its nonconducting state, the anode voltage must be reduced to zero, as in the case of a thyratron.

Basic Principles

An SCR is fabricated from four alternate layers of N and P type silicon, as shown in Fig. 1. Hence, an SCR is also called a four-layer diode. The four-layer switch can be regarded as a two-transistor construction (Q1 and Q2). The NPN unit has a narrow base, and the PNP unit a wide base. The emitter current tends to become very large at a certain value of applied voltage called the "forward voltage breakdown point". The forward breakdown-voltage value can be set by adjusting the base bias. More detailed characteristics for an SCR are shown in Fig. 2. In the forward nonconducting region, an increase in forward voltage does not result in a current increase until the point is reached at which avalanche multiplication occurs (Knee point). Beyond this point, the current increases rapidly to a value sufficiently great to maintain the knee point.

At the knee point, the device goes into a low-resistance, high-conduction state, provided the current through it remains greater than the minimum holding-current value (I^H). An SCR requires a certain minimum value of anode current to maintain the device in its "off" condition. If the anode current falls below this minimum value, the SCR reverts to its "On" condition. The holding current for a typical SCR has a negative temperature coefficient; therefore, if the junction temperature increases, the holding current must be greater to maintain the device in its "off" condition. A value of anode current greater than the holding-current is required for

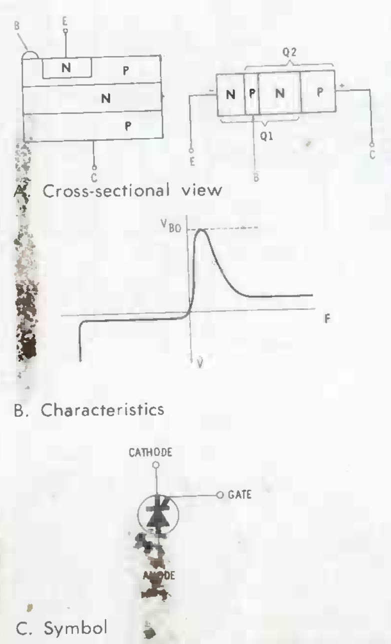


Fig. 1. Construction and characteristics of an SCR.

the SCR to "pick up" conduction after the gate signal is removed. If this minimum anode current is not maintained, the SCR will return to its "off" condition as soon as the gate signal is removed. Immediately after this "pick up" interval, however, the anode current may be reduced to the holding-current value and the SCR will remain conducting.

To turn off the SCR quickly, it is necessary to apply a reverse voltage to the anode. The voltage across the SCR will remain about 0.7 volt as long as an appreciable reverse current flows. After the charge carriers have been swept out, the SCR goes into its blocking state and the reverse voltage across the SCR increases to a value determined by the circuit and the supply voltage. The SCR remains in its blocking state until another trigger pulse is applied. (This operational sequence actually entails the sweeping out of charge carriers from a pair of junctions, and includes recombination in addition to drift in an electric field. However, a comprehensive analysis of solid-state action is not required here for our purposes.)

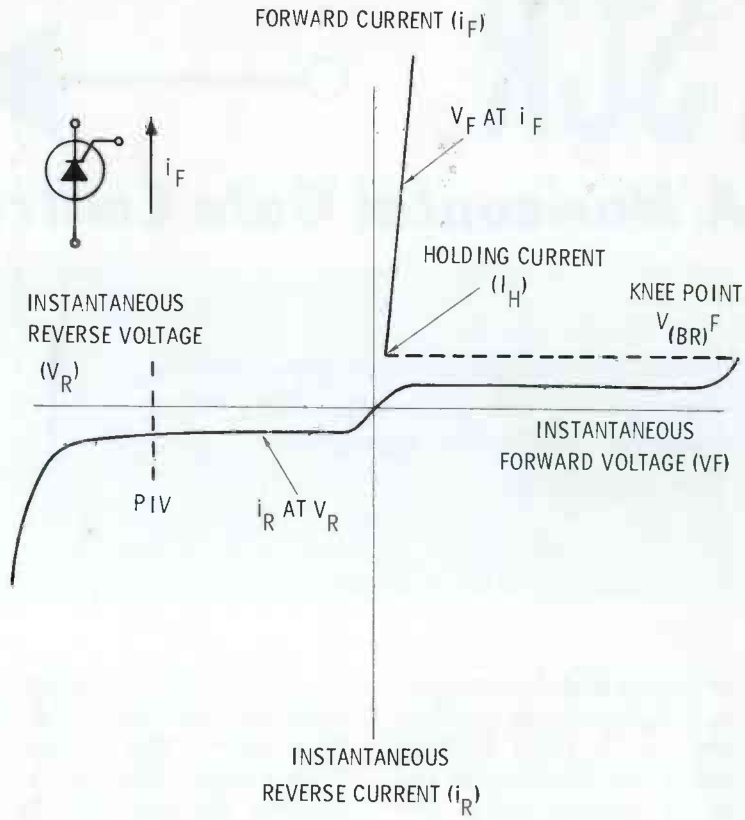


Fig. 2. Detailed characteristics of an SCR.

Horizontal-Output Configuration

Fig. 3 depicts a horizontal-output circuit that uses an SCR. When a gating pulse from the driver is applied to the gate electrode, the SCR conducts and the leading edge of a square-wave voltage is applied to the yoke, the high-voltage transformer, and the boost circuit. The impedance of the system is such that a linear sawtooth current waveform flows through the yoke. At the end of the first half of the forward-scan interval, the output waveform automatically applies a reverse voltage across the SCR, which goes into its nonconducting state. A peak current of 3 amps can be switched off in 0.2 microsecond. The SCR remains in its nonconducting state until the next trigger pulse is applied.

Magnetic field energy stored in the yoke produces an inductive

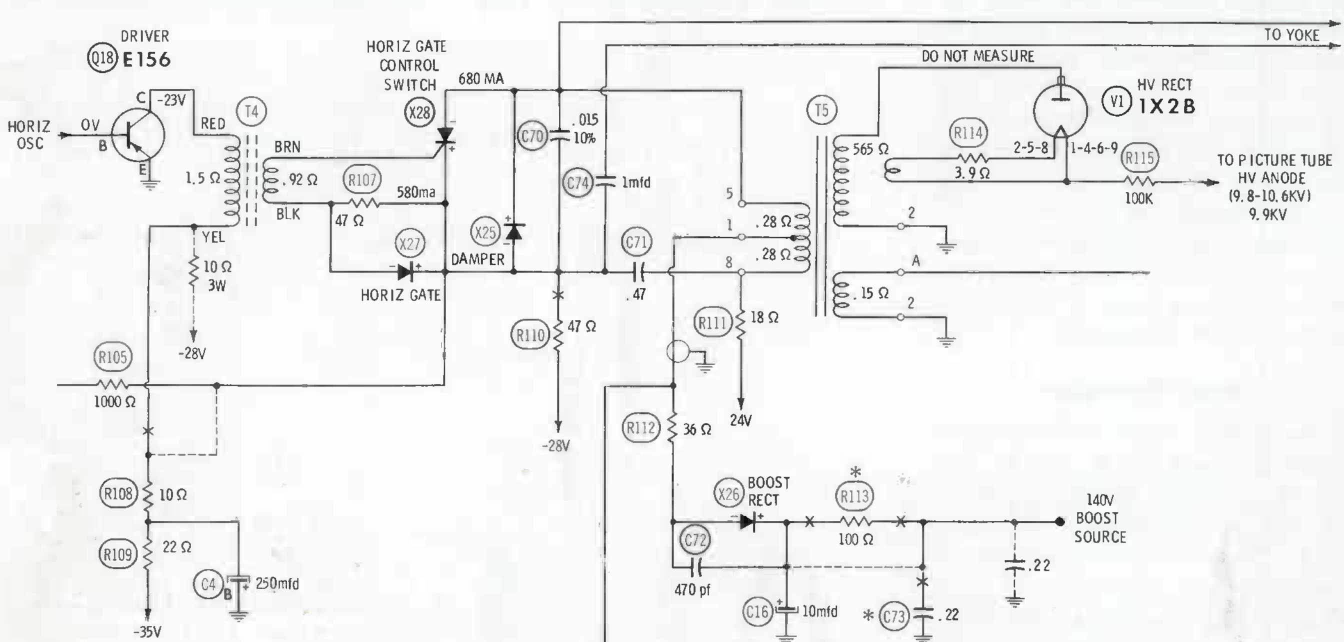


Fig. 3. Horizontal-output circuit employing a silicon-controlled rectifier.

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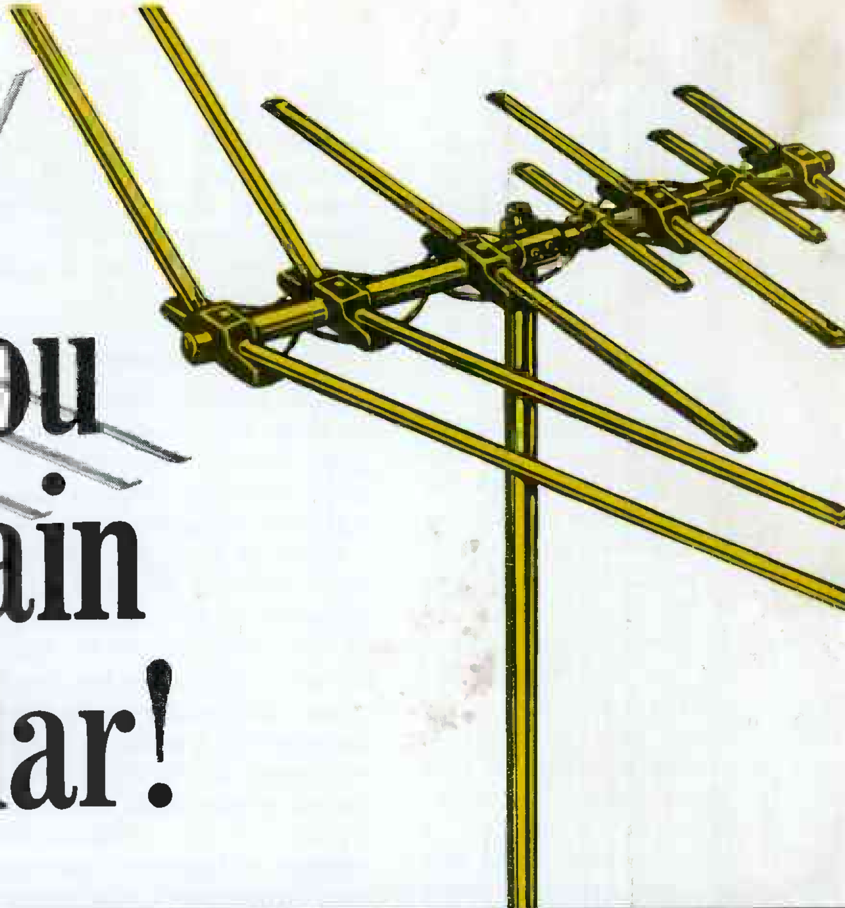

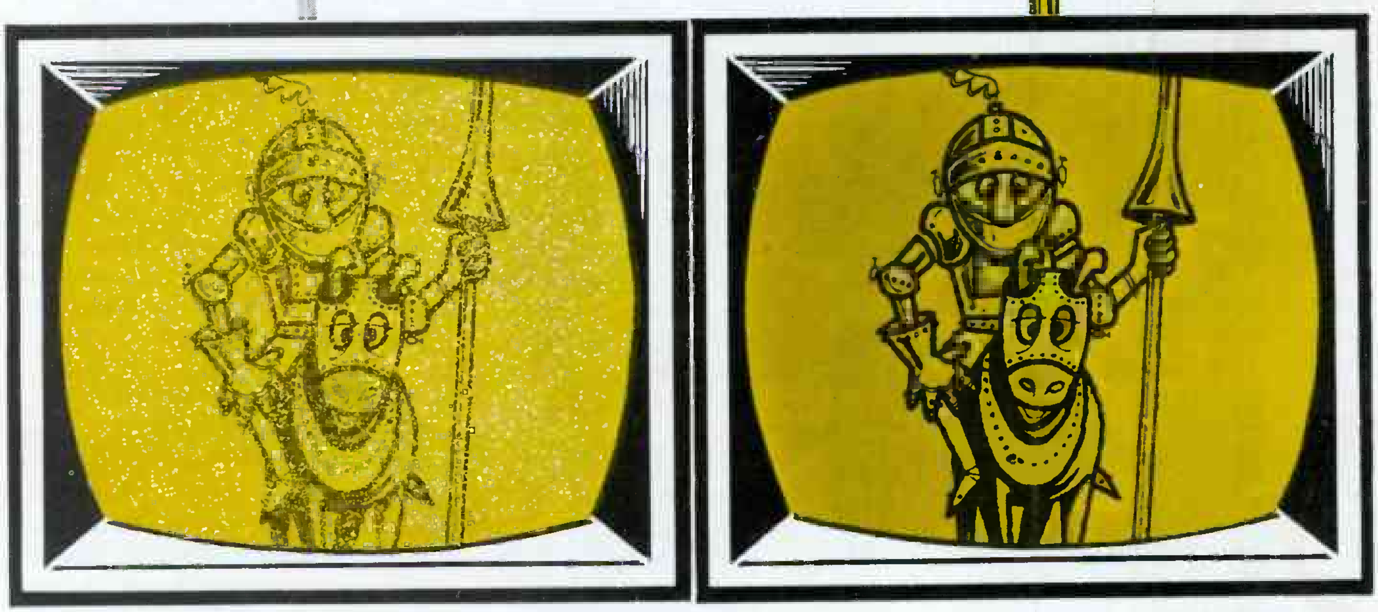

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kickback that is rectified by X26 and, in turn, charges the boost capacitor to 140 volts. Transformer T5 steps up the kickback pulse, which is rectified by V1 to produce a 10kv DC output for the picture tube. Thus, the yoke inductance and its associated circuit capacitance develop a half cycle of ringing oscillation; the other half cycle of oscillation, which would otherwise occur, is damped by diode X25.

During the second half (approximately) of the forward scan, current increases linearly through the yoke. Next, the damper diode starts to conduct and the stored energy in the yoke produces the remaining portion of the forward scan. In other words, stored magnetic energy in the yoke has a flywheel effect that maintains current flow in the same direction until it decays to zero. The circuit impedance is such that the decay occurs linearly to provide the first half of the scan.

SCR X28 is normally gated into conduction slightly before the stored energy in the yoke and high-voltage transformer has decayed entirely to zero. This insures that the scanning sawtooth will be quite linear.

The flyback interval is rapid because the LC system starts to ring at about 50 kHz the instant that the SCR cuts off. As noted previously, only the half-cycle of ringing can occur because the damper conducts on the second half of the ringing sequence. The scanning beam in the CRT rapidly returns to the left side of the screen, and then proceeds through the first half of the forward scan as the stored energy in the system discharges through the damper diode. The horizontal gate diode, X27, insures that a positive-going gating pulse is applied to the SCR so that it will be properly cut off by application of the output waveform. Timing is not highly critical, although the gating pulse should be applied slightly before the first half of the scanning interval is completed.

A protective circuit is generally required to prevent circuit damage in the event of gate-drive failure. R110 limits the maximum current flow from the source to approximately 0.6 amp. Capacitor C4 improves the regulation of the DC supply for the SCR. Capacitor C74 blocks DC current flow through the yoke, and also serves a waveshaping function to obtain linear scanning. T4 is an impedance-matching transformer that changes the comparatively high impedance of Q18 to the lower value of input impedance presented by X28.

Gate Characteristics

Gate and ring characteristics of an SCR are usually shown in a graph form, as seen in Fig. 4. The graph shows the range of gate currents and voltages required to fire a typical SCR. It also indicates the limit values of the voltage-current characteristic between the gate and cathode curves (A and B). The gate current requirements for firing decrease substantially as the junction temperature increases. Although not shown in the figure, the gate current requirements also decrease slightly as the anode-to-cathode voltages is increased. Because of these temperature and anode effects, it is desirable to fire an SCR with a steep wavefront of gate current—fast rise insures accurate timing.

For reliable firing under various temperature conditions, the gate pulse should provide peak voltage and current values in excess of those indicated by the shaded area in Fig. 4. However, to avoid possible damage to the SCR, maximum device ratings must not be exceeded. To

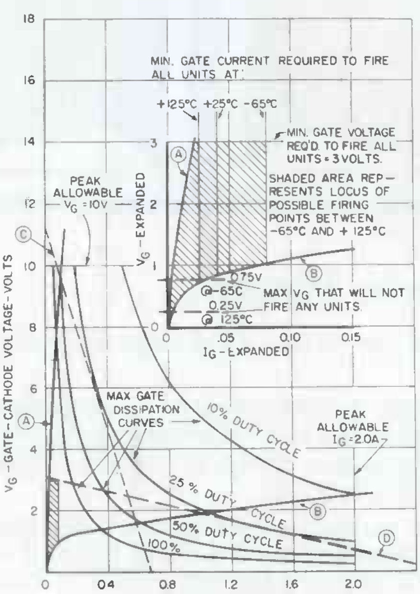


Fig. 4. Gate and firing characteristics of an SCR.—Courtesy, G.E.

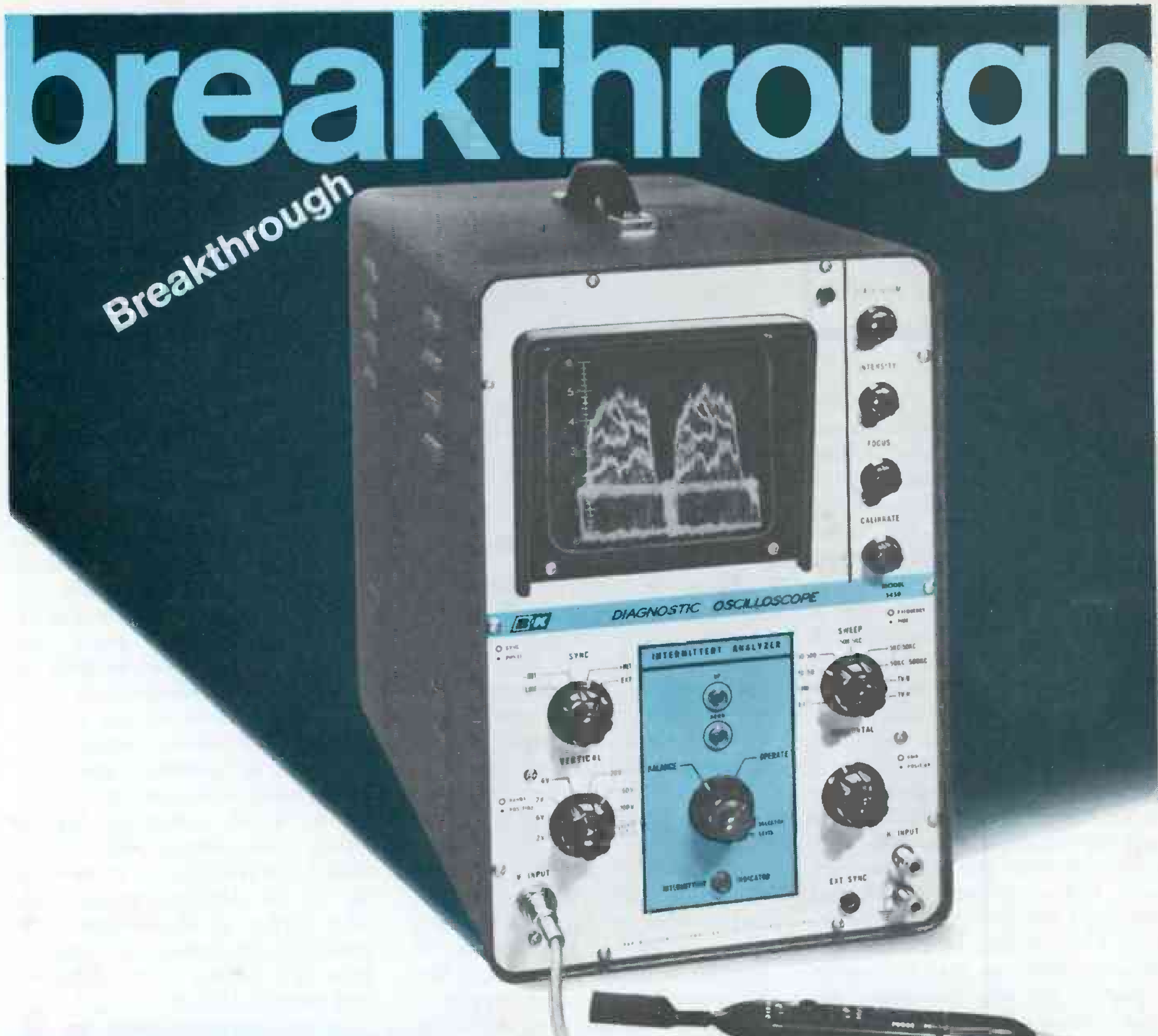
assist in understanding gate-signal load lines, the maximum permissible power-dissipation curves for the various duty cycles of gate signal have been shown in Fig. 4. For positive firing, load lines should be above and to the right of the shaded area. Load lines must also be below and to the left of the maximum power dissipation curve that applies for the particular duty cycle. The duty cycle is the ratio of the pulse width to the pulse period. Dashed lines C and D in Fig. 4 denote the maximum limits of load lines at 25% duty cycle for the particular SCR under consideration.

Fig. 4 also illustrates the gate voltage level below which the SCR in this example will not fire. The foregoing considerations are of basic importance when troubleshooting an SCR horizontal-output system. A calibrated scope should be used so peak voltages may be measured and compared with the values specified in the receiver service data. If the receiver is in horizontal sync lock, and knowing that the scanning period is approximately 63 microseconds, pulse widths may be measured by waveform analysis. Otherwise, a scope with calibrated triggered sweeps must be used.

Although the SCR horizontal-output circuit is essentially different from tube-type and transistor-type circuits, its circuit action is not more difficult to understand.

Troubleshooting

When troubleshooting SCR's, waveform checks are the best bet, followed by DC voltage measurements. Capacitors are the most common troublemakers, followed by junction leakage in semiconductor devices. Diodes may be checked for front-to-back ratio. If an SCR appears to be defective, a substitution test is generally best. An open transformer winding is easily found by an ohmmeter test, but, a definite indication of shorted turns may not show up on a resistance measurement. Here again, a substitution test is advisable. In summary, troubleshooting procedures are basically the same as those for any horizontal-output system, in spite of the fact that an SCR system involves different circuit action. ▲



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Transistorized AGC

An analysis of the operation and servicing of automatic gain control circuits employing semiconductors.

by Jack Darr

AGC is AGC is AGC. No matter where you find it, the basic purpose of this circuit is the same. It must generate a *control voltage* that is directly proportional to the amplitude of the incoming RF signal. The control voltage is applied to the controlled stages to regulate their gain, so that the output will stay at the same level at all times. This is under ideal conditions, of course, and there aren't any such things such as ideal conditions, but we try.

In tube-type TV sets, we control the tuner and IF's by developing a negative bias voltage that increases as the signal strength rises. Negative grid bias cuts down the gain of all controlled tubes. In transistor sets, we'll find a different means, but the result will be exactly the same. Let's look at some of the different circuits you'll run into in modern transistor TV sets. Remember, the AGC *action* will still be the same: The voltage which is developed will cut down the gain of the controlled stages; however, in solid-state receivers the control voltage may go either positive or negative!

Voltage and Current "Thinking"

Let's take a minute here to examine a new way of thinking about voltages and currents in transistor sets. The old-timers have always said that the plate voltage "goes up" when they mean that it goes more positive. We ought to stop using such descriptions; they can confuse us, and *that* we don't need—we have enough things to confuse us as it is.

Obviously, if we had a transistor with a negative collector voltage, and it "went up", it would be going *more negative!* So, start thinking of voltages in terms of *polarity!* Say to yourself "goes more negative" or "goes more positive" instead of "going up" or "going down." It'll help you keep things straight.

Also, in this discussion we'll be talking about "base voltage" instead of "base current". I know the bit about transistors being current amplifiers, etc., etc. However, we can, and must, read *voltages* instead of current for this simple reason: to read voltages, all we need is a quick jab with a voltmeter probe. We don't have to unsolder anything to make a voltage measurement; however, we do when we put an ammeter in the circuit. Voltage measurements in transistor circuits are just as accurate as current measurements. Until somebody repeals Ohm's Law, voltage will still be directly proportional to current, so we get the information we need. This applies to all elements of a transistor, of course, as long as there is a resistor in the circuit—and there usually is.

In this discussion, we'll use the terms collector (plate), base (grid),

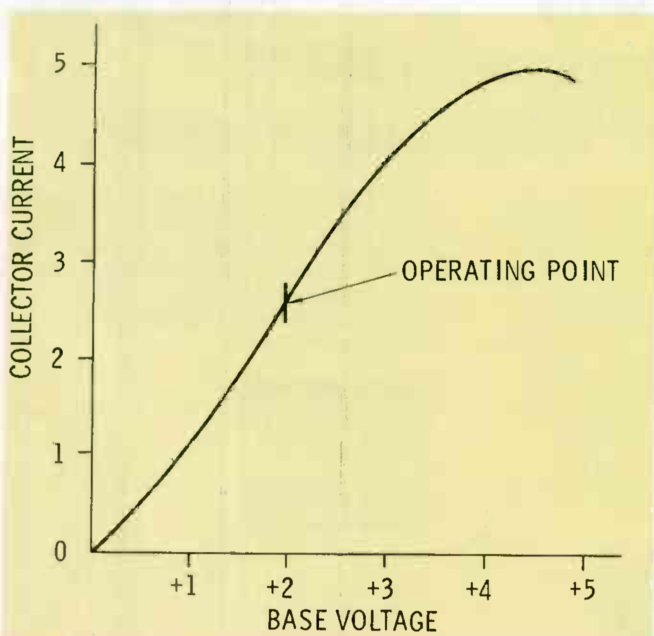


Fig. 1. Collector current-base voltage curve of low-beta transistor.

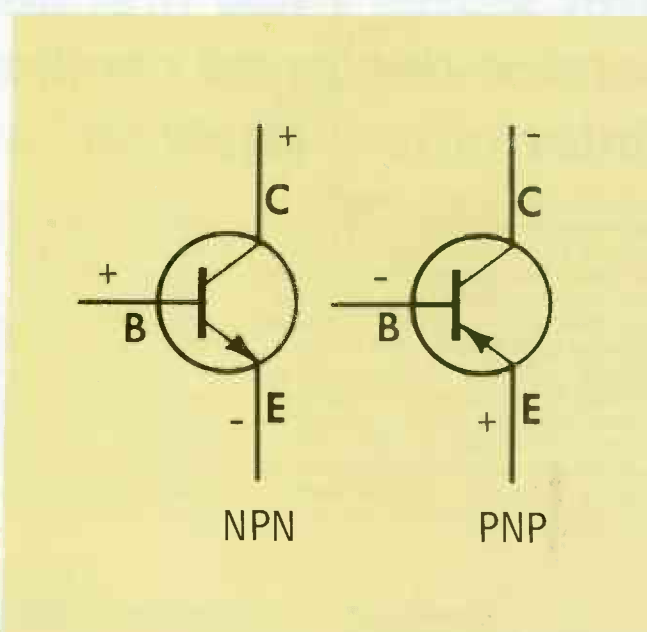


Fig. 2. Forward bias polarities for NPN and PNP transistors.

and emitter (cathode) to refer to the elements of a transistor employed in a common-emitter circuit (equivalent to grounded-cathode tube circuit). As far as I can see, practically every major manufacturer uses this circuit in AGC stages; so we will thankfully use it too. It gives us a familiar "handle" with which to grasp AGC circuits since the basic configuration is exactly the same as the tube-type AGC circuits we've been working with for so long.

Forward and Reverse Bias

For maximum conduction, a tube's plate voltage is always positive and the grid negative with respect to the cathode. However, a transistor can operate, and be controlled, with voltages of either polarity. A negative-going voltage on the P element is "reverse bias"; a positive-going voltage on the same element is "forward bias". Let's see how this works.

If we put a negative-going voltage on the base of a NPN transistor, it would be reverse biased. We'd have a collector current-base voltage curve that looked something like Fig. 1. Note the similarity of this curve to the plate current-grid voltage curve of a tube.

The transistor in Fig. 1 normally operates at the point labeled "operating point" because we put a *fixed* bias of +2 volts on it. As you can see, if the base voltage goes more negative (less positive), the collector current will go down. (With current, we can still say "go down" or "go up", if we want.) The preceding example is for an NPN transistor; for a PNP, just reverse the polarity of the voltages. The action will be the same.

If the AGC voltage applied to an NPN transistor causes the base voltage to go from +2 volts to +1 volt, it is "going negative", and the collector current (and signal gain) of the stage is reduced. Fig. 2 shows the polarity of bias voltages with respect to the emitter for each type of transistor.

The curve in Fig. 1 is the kind of curve that would be obtained with a low-beta transistor in the controlled stage. Such a transistor operates at maximum gain under low-signal conditions. The collector curve rises slowly as the base voltage goes more positive.

Forward Bias For Control

Normally, forward bias on a transistor makes it conduct more current, thus increasing the gain. Then, you may ask, how can we use a "forward-going" bias as a control to *reduce* the stage gain? Simple, but sneaky—we just use a special transistor.

The gain curve of such a transistor is shown in Fig. 3. Note the very steeply rising collector-current curve, which reflects a high beta. The transistor used for this illustration is biased to operate at maximum gain with +1 volt. Such a transistor can have a very high gain compared to the type of transistor used to obtain the curve in Fig. 1.

The most significant fact about the curve in Fig. 3 is that it slopes downward with an increase in positive base voltage beyond the operating point. This is simply the "nature of the brute"; in other words, that's the way this kind of transistor works. So, if we make the AGC voltage go more positive with an increase in signal strength, we can control the transmitter stage gain. This method is called "forward AGC".

At this point we should mention that it is good practice to use exact-duplicate transistors as replacements in critical stages such as forward AGC circuits. If we should happen to get a replacement transistor with the wrong kind of gain curve, you can see what would happen: The gain of the controlled stage would be going up instead of down when the signal increased, and we'd have all kinds of built-in AGC trouble.

Keyed AGC

Nearly all transistor sets use keyed AGC. Any element of the transistor can be keyed, just as in tube circuits. You won't find 600-700 volt p-p keying pulses in transistor AGC circuits as you do in tube sets, since transistors don't need such amplitudes. The keying pulses employed in transistor circuits are taken from the flyback and are the same shape, but the p-p voltage varies from about 75 volts in the Motorola TS-594 chassis (collector-keyed) down to as little as 5 volts p-p in the Westinghouse V-2483-1 chassis, which uses base-keying. This corresponds to plate-keying and grid-keying in vacuum tubes, respectively. When troubleshooting, just check the p-p voltages and polarity of the keying pulses on the PHOTOFACT schematic. They are always shown as being on the keyed element of the transistor.

Typical Circuits

Let's take a simple system apart and see what makes it tick. The Westinghouse V-2483-1 chassis (PHOTOFACT Folder 816-3) uses only one transistor, as shown in Fig. 54. The actual generation of the AGC control voltage is the same as in a tube-type receiver. A small video signal, 1.6 volts p-p, is taken from the 2nd video amplifier transistor (an emitter-follower) and fed to the base of the AGC keyer, Q7. At the same time, a 5.3-volt p-p keying pulse is applied to the base through R83 (4700 ohms). The other end of the small AGC pulse winding (terminals 5 and 9 on the flyback) returns to +12 volts for bias purposes. R84, 120K ohms, goes back to +60 volts. The net result is +15-volt bias on the base and +12 volts on the emitter. This is the no-signal (DC) bias condition that sets the operating point of the AGC transistor.

Thus, since we have about 3.0 volts of reverse bias on Q7, it won't be conducting on the video portion of the signal; only the horizontal sync tips will drive it into conduction. This gives us the same noise-

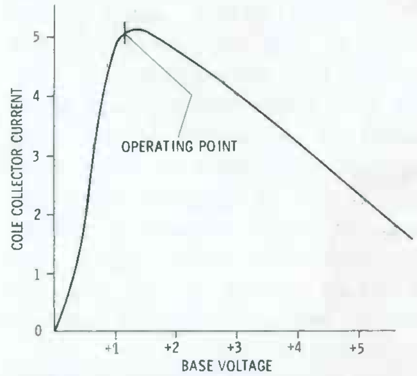


Fig. 3. I_C-V_B curve for a high-beta transistor suitable for AGC circuits.

immunity that we get in tube-type keyed AGC circuits. The amplitude of the sync tips regulates the conduction of the keyer transistor and, consequently, the amount of AGC voltage developed across the collector load resistor, R82. Notice that this resistor goes to ground; there is no external voltage supply. Thus, there will be no collector voltage developed at all, unless there is collector-current flowing. This last point is worth remembering since it's one of the main clues we use in servicing this or any other transistor stage.

The collector voltage of Q7 is the AGC voltage. When the signal strength increases, the height of the sync tips also increase, the transistor conducts more, and the AGC voltages changes in the direction necessary to reduce the gain of the controlled stages back to the original level. If the signal level falls off, the AGC voltage changes in a direction that will raise the gain of the controlled stage.

"What Are All Those Diodes For?"

Next, we get into a seemingly complicated, but actually simple, part of the circuit. Notice that there are three diodes employed in the circuit. Each one has a purpose. X32, in the base circuit, is used to control the applied video signal and to insure that only the right polarity of signal is applied to the keyer transistor base. Any spikes of the wrong polarity are blocked by this diode.

X33, in the IF AGC branch, is actually used as a "gate". Notice the voltage divider consisting of R80, R79 and the AGC Crossover control, R6. This network sets the DC voltage on the anode of the diode so that the diode will not conduct until the applied AGC voltage goes above a preset level determined by the setting of R6. This prevents application of AGC voltage to the IF stage(s) until the received signal exceeds a certain amplitude. For weak signals, the IF stages operate at full gain; no control voltage is applied until it is needed.

The tuner AGC system works in the same way, but it doesn't get into the act until even later. after the IF AGC has done all it can. The voltage divider for the tuner AGC is R78 and R77, from +12 volts to ground. This positive voltage is applied to the cathode of X34 and keeps the tuner AGC from being effective until after the IF AGC voltage has reached its practical limit of control. This leaves the RF amplifier working at maximum gain during weaker signals to get the cleanest possible signal into the IF stages.

When the signal rises above this preset IF AGC level, X34 begins to conduct, and the RF AGC bias is applied to the tuner to help reduce the overall gain of the receiver. This tuner delay system is basically the same as the RF AGC delay circuits found in tube-type sets, including the function of X34, which clamps the RF AGC to keep the tuner at maximum gain until the maximum control level of the IF AGC has been reached.

Two-Stage AGC With Driver Stage

The basic design of the two-stage AGC circuit shown in Fig. 5 is employed in Motorola, Zenith, Sylvania, Magnavox, RCA, and several other chassis. Basically, it consists of a keyed AGC stage like the one discussed previously, with an added stage of DC amplification. This latter stage is usually labeled "AGC Driver" or "AGC Amplifier," depending upon the manufacturer.

The specific design shown in Fig. 5 is the basic keyer circuit employed in Magnavox 908 and 915 chassis (PHOTOFACT Folder 819-3). This part of the circuit handles only the IF AGC and is designed for signal inputs up to 1,000 microvolts. Note that there is a permanent, or fixed-bias, voltage of +3.5 volts at the IF AGC tap. This bias sets the IF amplifier stages at maximum gain with no signal applied. Because this is a forward-biased AGC system, as the AGC voltage goes more positive, the IF gain goes down. The actual values vary, of course, but this system can produce gain-reductions up to about 40 dB.

During a no-signal condition, the AGC keyer is biased so that its conduction is very small, or even zero. Electrolytic capacitor C10 is charged through voltage divider R65, R63, R62, and diode X30 to about +3.5 volts, which sets the IF bias. A video signal of about 1.5 volts p-p, from the video driver stage, is applied to the base of the AGC keyer, Q6. Because of the fixed bias, only the sync tips can trigger Q6 into conduction. The sync tips must be applied to the base at the same time as a negative-going, 34-volt pulse from the flyback is applied to the collector. This keying action provides noise immunity.

When the video signal reaches the right amplitude, the transistor begins to conduct. Its collector current—through the resistors and diode X30—causes the charge on C10 to increase (become more positive). This positive-going voltage puts a higher forward bias on the IF transistors and reduces their gain. In medium-signal areas, the AGC keyer stage does all the work by itself.

The AGC Driver Stage

Now, let's add another stage—the AGC driver, or amplifier. Fig. 6 shows how this stage is added to the circuit. All of the circuitry of Fig. 5 is still there; however, a diode and a variable resistor (X26 and R10) have been added to give us some adjustment of the operating point of the IF amplifier stages. In addition, the diode acts as a clamper.

A positive 4.2 volts, obtained from the 12-volt source via voltage divider R10 and R19, is applied to the cathode of X26. When the IF AGC voltage reaches about 5.0 volts, X26 is completely forward-biased (saturated) and tends to hold the IF AGC voltage very close to this 5-volt level. This is about as high as the AGC voltage should go if distortion and IF clipping of the sync, etc., are to be avoided. Now, the AGC driver stage, which has just been sitting there doing nothing, gets into the act. It takes over the AGC control function for signals that go above 1,000 microvolts, while the IF AGC remains at the 5-volt level.

Q7, the AGC Amplifier, has a voltage dependent resistor (VDR), R69, connected in series with its base. With no voltage applied, R69 has a high resistance (about 300K ohms). When the IF AGC voltage goes far enough positive, the VDR resistance goes down, which, in turn, increases the voltage drop across R70 so that the voltage at the top of R70 becomes more positive. This forward biases Q7, and it conducts. When the AGC amplifier starts to conduct, the "rate of gain reduction" of the IF AGC slows down.

Meanwhile, a voltage divider (Rx and R13) in the emitter circuit of Q7 has been holding the RF AGC at a fixed level of about 1.5 volts forward bias, producing maximum tuner gain, least snow, etc. When the AGC amplifier starts to conduct, more current flows through the emitter resistor, R13, and the RF AGC voltage gets more positive. This cuts down the gain of the RF amplifier stage.

Actual gain-reduction figures for the IF AGC in this chassis, if you're interested, are about 40-50 dB reduction for an input signal level up to about 1,000 microvolts. About 40 dB more reduction is added by the RF AGC for high-input signals up to about 50,000 microvolts. (This last input level is what you might get if the set were operated in the vicinity of a powerful TV transmitter.)

This and That, and What and Why

Now, a few odd comments about some what's and why's in transistor AGC circuitry. As usual in keyed circuits, the AGC keyer transistor will have no fixed or external collector voltage supply. Its voltage comes in the form of pulses from the flyback.

In the circuit of Fig. 6, diode X28 is connected between the pulse winding and the collector. It keeps the keyer from conducting unless the pulse voltage is present. Also, any pulse taken from an inductive circuit (a coil, where most of them do originate) will have a little bit of overshoot, or small excursion in a negative direction. If this overshoot is allowed to reach the collector of Q6, it will forward bias the collector and could destroy the

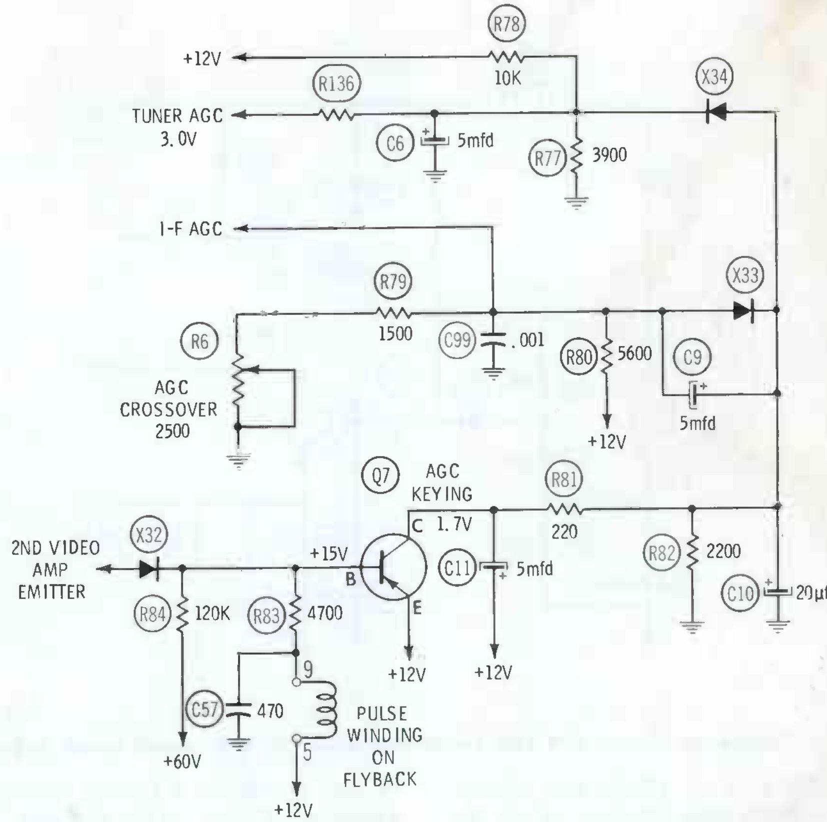


Fig. 4. AGC keyer stage employed in Westinghouse V-2483-1 chassis.

transistor as a result of excessive conduction. This can happen very quickly—in a microsecond or two.

The other diodes in the circuitry of Fig. 6 are gates or clampers. By putting a fixed DC voltage on them (through voltage-dividers), they can be made to hold off or conduct until the circuit voltage reaches a desired level.

To "stabilize" a given voltage, we simply connect a capacitor across the circuit. Then, the current pulses from the AGC keyer charge this capacitor to a certain level determined by such factors as the size (amplitude) of the pulse voltage, current through the associated resistor, etc. The AGC voltage, bias, or whatever it is, will then be clamped, or held, at the level needed by the "storage" action of the capacitor. (Does this sound familiar? It certainly should since—it's the way all DC power supplies work. A rectifier feeds a pulse of

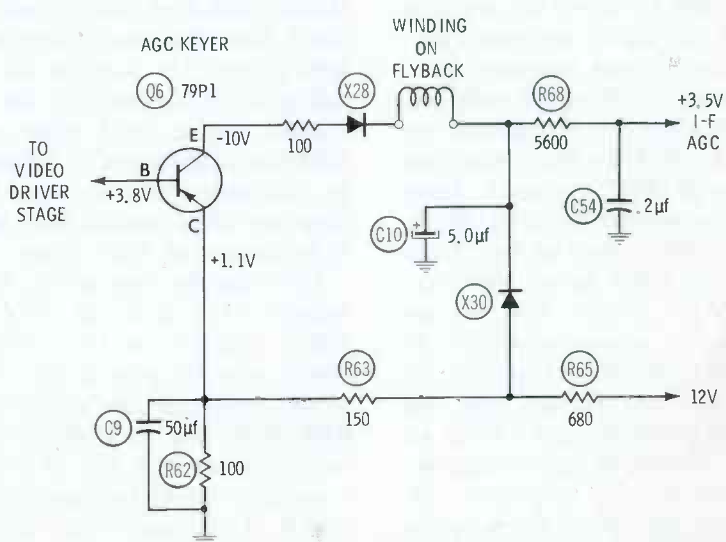


Fig. 5. Partial schematic of AGC circuit employed in Magnavox chassis.

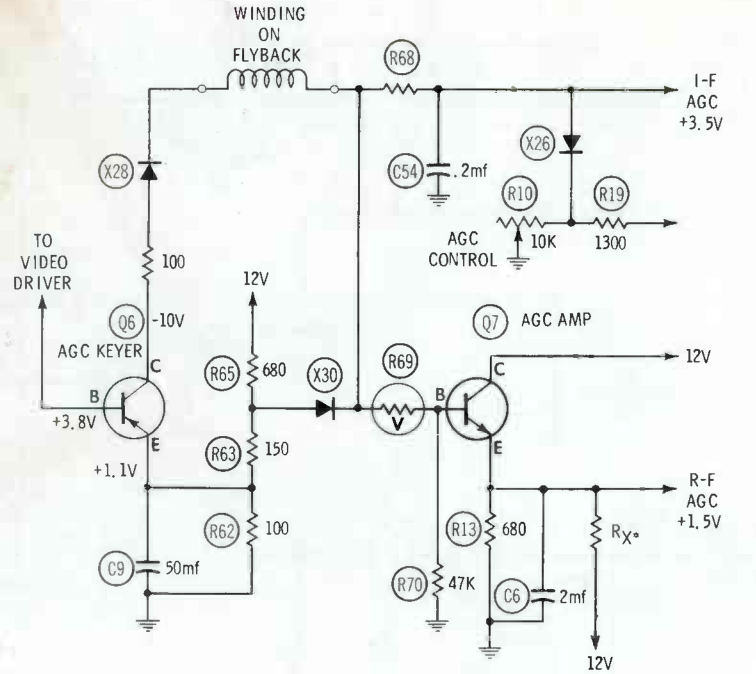


Fig. 6. Magnavox Chassis 908 AGC circuit with amplifier and control circuit added.

current into an electrolytic capacitor, which then charges up to the peak voltage level. This voltage can be taken off the "top" of the capacitor and used to supply the operating voltage to all the other circuits. The capacitor is then the "reservoir" or "input filter". Same thing here.

Servicing Techniques

Now that we've discussed how they work when they are working, let's see what we can expect to find when they are not working. For one thing, there won't be any AGC, or there will be either too much or too little. (If there's anything I like, it's a nice obvious statement.)

Seriously, you'll see the same picture symptoms on a transistor receiver as you'd see on a tube-type TV set with AGC problems. There will be the normal whiteout, blackout, sync buzz, and so on. There is one thing you'll notice with transistor AGC circuits that is not common in tube-sets—snow. In some cases, you'll find quite a bit of snow in the picture, and the cause will probably turn out to be an AGC defect. If you rotate the AGC control of a transistor TV through its full range, at one point you may see quite a bit of snow in the picture. This seems to be more or less normal at a certain voltage. However, if the AGC circuitry is working properly, you will be able to set it up for a good, clean picture. The whiteout at one end and blackout at the other will still be there, and you will be able to determine whether or not the AGC has sufficient range of control.

Conduction

As you can see from the circuits shown, the AGC voltage is developed by transistor conduction. Current must flow before anything can happen. If there is a circuit fault—such as a leaky capacitor, bad resistor, shorted or leaky transistor—you'll have too much current, too little current, or none at all. This will upset voltages all over the place—even two or three stages away. With the high degree of interaction in transistor circuitry, one faulty stage can cause trouble that appears to be in two or three others.

For example, look at Fig. 6. The resistor (R_x) from the AGC amplifier emitter to the +12-volt source actually goes to the middle of the voltage divider comprised of R65, R63, and R62; however, we have redrawn it in Fig. 6 to avoid a possible misinterpretation of the circuit. The supply side of R_x is actually nothing but a DC supply point, but if it were drawn connected to the divider, as it physically is, it might look like a signal-transistor connection. So watch out for this kind of thing when you're tracing out circuits.

Voltage Drops

One of the easiest methods of checking out transistor circuits is by measuring the voltage-drop across associated resistors. Yes, transistors are still supposed to be current-amplifiers, but as we said before, and repeat for added emphasis, until they repeal Ohm's Law, voltage drop will still be directly proportional to current through all fixed resistors. Voltage measurements are, and will always be, the quickest way of checking out a circuit; so why not use them to locate the trouble.

A circuit common to all transistor sets is the grounded-collector with no external voltage supply. Although no voltage is fed to this element, it still has a DC voltage on it. Fig. 7 shows the basic circuit.

The transistor collector goes directly to ground through R_c, but it measures +1.7 volts. This voltage is developed by the collector current flowing through R_c to ground.

Fig. 4 shows another example in an actual circuit. Note that the collector of Q7 has no DC voltage applied to it. Instead, it goes to ground through R81 and R82. The normal no-signal collector voltage is about +1.7 volts, and is the result of collector current flow through R81 and R82. If you want to waste a little time, you can figure out the actual current. But why bother? If the normal voltage drop is present, the current has to be normal, unless the resistors are off

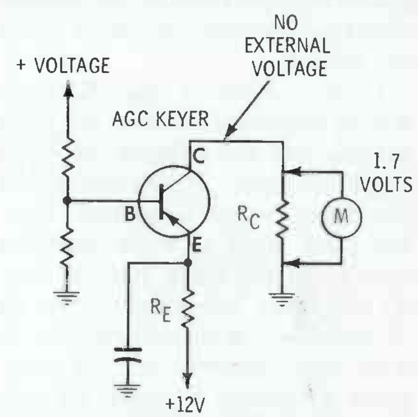


Fig. 7. Collector of typical transistor keyer has no DC voltage source.

value. This last possibility can be quickly checked with a very complicated test instrument called an ohmmeter.

If there is no voltage, there is no current, and it is safe to assume that the transistor is cut off (by too much reverse bias, or by an open circuit inside the transistor, or a bad solder joint). If there is too much voltage across the collector resistors, there is too much current flowing; in which case the transistor either has too much forward bias or it has an internal leakage. In either case, if the collector voltage is abnormal, it means trouble.

There is one thing you must watch for, especially in AGC circuits. This is the normal difference between no-signal DC voltages and the same DC voltages when there is a large RF signal applied. You'll find a vast difference in voltage levels between the two extremes, and this is normal; if not, you'd have no AGC action. However, the voltage given on schematic diagrams are always read with no signal applied, unless otherwise stated.

Transistor Leakage

When actually servicing transistor AGC, the most puzzling condition you will run into is internal leakage in the transistors. This seems to be mainly collector-to-base leakage, or excessive I_{cbo}, which upsets the "control ability" of the transistor.

In most cases, this fault will not show up on an in-circuit test of the transistor; there are always too many shunt paths in the circuitry. The transistor will show a normal beta (gain) reading, yet the stage will not work. The only way to get a reliable leakage reading is to take the transistor completely out of the circuit, then read the leakage.

Germanium transistors have a small allowable leakage, up to a few microamperes. The silicon transistors that are showing up more often in late-model sets should have zero leakage—no measureable leakage at all. In one of the AGC keyer circuits shown here, we found a severe upset of all voltages, and the AGC wouldn't work at all. The beta test showed the transistor to be well inside the ballpark. When it was removed from the circuit (finally) and checked for leakage, it produced a reading of about 12 microamperes. Replacing it with a new transistor that showed no leakage cured the trouble symptom. So, when you run into one of those "everything is normal but the darn thing won't work" problems, remove the transistor from the circuit before checking it for leakage. Symptoms will ordinarily be nice and obvious. In the case of the AGC keyer, we read +6 volts on the collector, instead of the normal −10 volts. This confirmed the initial diagnosis of AGC trouble made from the picture symptoms.

Conclusion

Generally, transistor AGC circuits are no more complicated, and in lots of cases far less complicated, than their tube counterparts. Diodes are easy to check; when they go, they usually short, and an ohmmeter test will catch this right away. Just remember how the voltage-drops are developed, and what causes them, and you'll have a nice useful set of clues for tracking down any AGC trouble in solid-state sets. ▲

How Are YOU and Progress Getting Along?

by J. W. Phipps

Catching up is much more difficult than keeping pace

The era of practical consumer electronics covers nearly 50 years, extending from the early cat-whisker crystal radio to the present design innovations involving Integrated Circuits (IC's). During this period of time the service technician has "weathered" many new developments. At first, progress was relatively slow, allowing the technician ample time to "become accustomed" to the new servicing requirements demanded by each new development. However, in the past twenty years, new developments in consumer electronics have come at an ever increasing rate—first television, then printed circuits, then color television, then the switch to transistors, and now the advent of integrated circuits.

It is doubtful that there is even one active electronic service technician who is not aware of the most recent developments in consumer electronics. Newspapers, trade publications, manufacturer's literature, and a host of other news sources continually provide him with up-to-the-minute reports on the state-of-the art. However, being informed and aware of new technological developments is not the full extent of the technician's obligation to himself and to an industry that depends on him to keep the consumers satisfied with the performance of the products they purchase. Just being aware that a new electronic device exists will not, in itself, prepare the technician for the day when he will come face to face with it in a product he is required to service.

The service technician must make an effort to understand the operation and application of each new device, as well as becoming familiar with any new servicing techniques associated with it. Without this "prior conditioning" to new developments, the technician must either refuse to work on "new" products or must farm them out to other technicians who have had the foresight to prepare themselves to meet the new servicing challenges that accompany new design and component developments in the consumer electronic industry.

The individual technician's reaction to new developments throughout the evolution of electronics has been as varied as the developments—and nearly as interesting.

Most technicians have recognized the need to adapt themselves to the changes in servicing techniques and attitudes demanded by new develop-

Fig. 1. Components contained in RCA's Experimenters Kit.

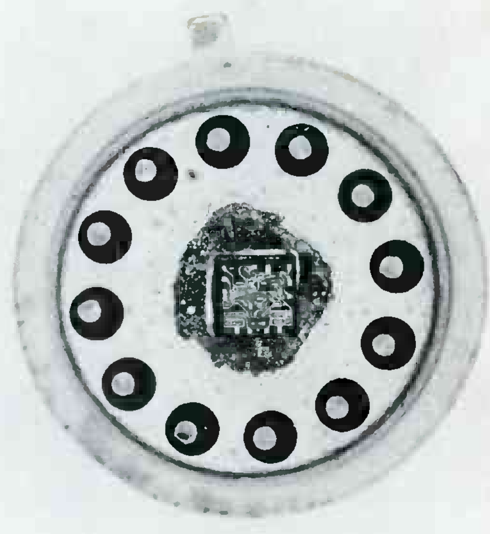


Fig. 2. Enlarged view of integrated circuit.

ments and have, as a natural course, prospered along with the other forward-thinking segments of the industry. A few technicians have openly and vigorously opposed any and all progress, declaring that such progress was, in reality, a conspiracy to eliminate the market for their services. Needless to say, very few of these "opposers" have survived.

Then there are those who have adopted a "live and let live" attitude toward new developments in electronics. These technicians do not openly declare their opposition to progress, they just ignore it—sort of a "head in the sand" approach. Some of these "ignorers" have survived and are still scraping a living from the consumer electronic servicing field, but by now they have had to tighten their belts many times, and there aren't many notches left.

Finally, we come to the service technician who recognizes the need for maintaining his knowledge and proficiency at a level consistent with the state-of-the-art, but who, for one reason or another, just never gets around to educating himself about "those new gadgets." He waits until he's actually confronted with a servicing problem involving a new device before forcing himself to take the time to learn about it. Of course, at this point the repair job must wait while he does a little cramming on the subject. Eventually, he will master the subject and repair the set, but in the process, because he was hurried by the presence of the waiting repair job, he will gain only a superficial knowledge of the new device. Chances are, the next time he comes in contact with the same device he will have to stop and indulge in a refresher on the subject.

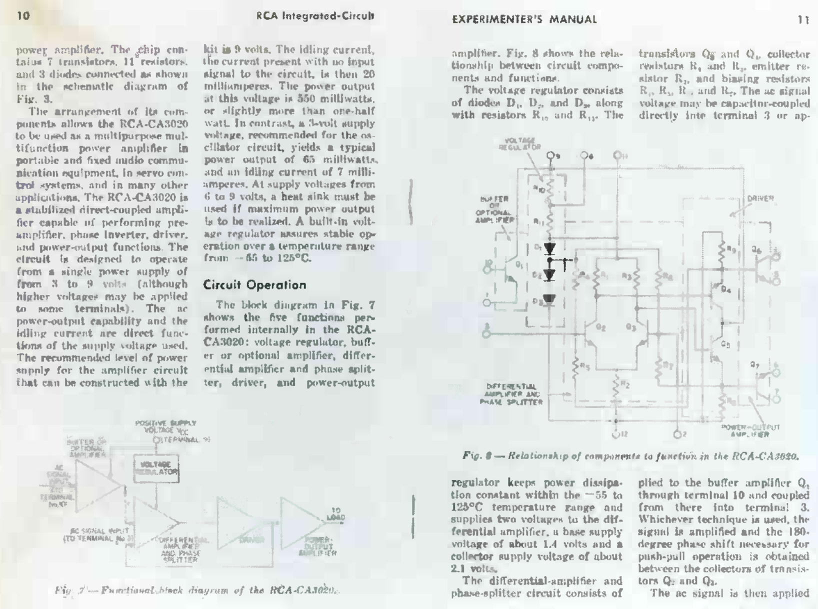
And so, through thick and thin, fair weather and foul, the service technician has arrived at the present state-of-the-art — the IC. For the present, the IC is the ultimate in microelectronic design.

The introduction and application of the IC has not been a sudden and all-encompassing thing. The first practical applications of the IC took place in early 1960, when various discrete, or separate, components in digital computer circuits were gradually replaced by IC's whose design closely resembled that of the discrete component circuits they replaced.

As better manufacturing methods were developed and more low-cost, general purpose IC's were produced, electronic equipment designers became more familiar with the characteristics of IC's. The application of the IC began to broaden, eventually finding its way into consumer electronic products—first in table radios, TV remote controls, and phono arms, then finally into the sound circuits of both b-w and color TV receivers.

The IC has followed hot on the heels of the transistor and, in actuality, has arrived at a time when many service technicians still regard the transistor as a "mysterious and devious" device. For those technicians who are already familiar with semiconductor devices and their associated servicing requirements, the mastery of circuits employing IC's will not be a difficult problem. But for those technicians who still regard the transistor with open-mouthed ap-

Fig. 3. Manual that accompanies integrated circuit kit.


10 RCA Integrated-Circuit

power amplifier. The chip contains 7 transistors, 11 resistors, and 3 diodes connected as shown in the schematic diagram of Fig. 3.

The arrangement of its components allows the RCA-CA3020 to be used as a multipurpose multifunction power amplifier in portable and fixed audio communication equipment, in servo control systems, and in many other applications. The RCA-CA3020 is a stabilized direct-coupled amplifier capable of performing preamplifier, phase inverter, driver, and power-output functions. The circuit is designed to operate from a single power supply of from 3 to 9 volts (although higher voltages may be applied to some terminals). The ac power-output capability and the idling current are direct functions of the supply voltage used. The recommended level of power supply for the amplifier circuit that can be constructed with the kit is 9 volts. The idling current, the current present with no input signal to the circuit, is then 20 milliamperes. The power output at this voltage is 550 milliwatts, or slightly more than one-half watt. In contrast, a 3-volt supply voltage, recommended for the oscillator circuit, yields a typical power output of 65 milliwatts, and an idling current of 7 milliamperes. At supply voltages from 6 to 9 volts, a heat sink must be used if maximum power output is to be realized. A built-in voltage regulator assures stable operation over a temperature range from −55 to 125°C.

Circuit Operation

The block diagram in Fig. 7 shows the five functions performed internally in the RCA-CA3020: voltage regulator, buffer or optional amplifier, differential amplifier and phase splitter, driver, and power-output

Fig. 7 — Functional block diagram of the RCA-CA3020.

EXPERIMENTER'S MANUAL 11

amplifier. Fig. 8 shows the relationship between circuit components and functions.

The voltage regulator consists of diodes D_1, D_2, and D_3, along with resistors R_{10} and R_{11}. The regulator keeps power dissipation constant within the −55 to 125°C temperature range and supplies two voltages to the differential amplifier, a base supply voltage of about 1.4 volts and a collector supply voltage of about 2.1 volts.

The differential-amplifier and phase-splitter circuit consists of transistors Q_2 and Q_3, collector resistors R_4 and R_3, emitter resistor R_2, and biasing resistors R_4, R_5, R , and R_7. The ac signal voltage may be capacitor-coupled directly into terminal 3 or applied to the buffer amplifier Q_1 through terminal 10 and coupled from there into terminal 3. Whichever technique is used, the signal is amplified and the 180-degree phase shift necessary for push-pull operation is obtained between the collectors of transistors Q_2 and Q_3.

The ac signal is then applied

Fig. 8 — Relationship of components to function in the RCA-CA3020.

Fig. 4. Illustrations supplement text of manual contained in kit.

prehension, the time is near when they will have to either catch up or drop out of the running.

Various segments of the consumer electronic industry have continued to play an active role in assuring that the service technician is provided with the information he needs to maintain his proficiency. One example of such assistance has shown up in the form of construction or experimenter kits that are designed to provide both operational and practical knowledge of a new device.

An example of such a kit is RCA's Integrated Circuit Experimenter's Kit (KD2112), shown in Fig. 1. Contained in the kit are the components necessary to construct either a .5-watt power amplifier or an audio oscillator. The component list includes one transformer, one potentiometer with control knob, four resistors, six capacitors, one printed-circuit board, and two RCA-CA3020 Integrated Circuits. (One of the IC's is a nonoperating unit with the top of its package removed so that the technician can actually view the IC with the aid of a magnifying glass, as shown in Fig. 2.) Also included are a heat sink for the IC, the necessary screws and nuts for mounting the transformer to the board, 18″ of rosin-core solder, and a 19-page instruction manual (shown in Fig. 3).

The manual is divided into two sections. Section 1 explains the construction of integrated circuits and describes the development of an integrated circuit from raw material (silicon) through to packaging. Also discussed in Section 1 are such subjects as classes of IC's; comparison of discrete (separate) and integrated components; and the characteristics, circuit operation, and various applications of the RCA-CA3020 integrated circuit. As shown in Fig. 4, circuit diagrams and illustrations supplement the text.

Section 2 of the manual provides detailed instructions for constructing both the power amplifier and the audio oscillator. Also included are special tips on handling IC's.

Shown in Fig. 5 is the completed audio oscillator. The only components shown here that were not included in the kit are the 9-volt battery, the 3.2-ohm speaker and the telegraph key. (A 3-volt battery will supply sufficient power to produce a comfortable output from the oscillator; however a 9-volt battery is recommended for use with the power amplifier that also can be constructed from the kit.)

After carefully studying the manual and then constructing and using either the audio oscillator or power amplifier, the service technician should have a practical knowledge of integrated circuits—how they are developed, their applications and the proper handling techniques they require. And equally as important, he will have taken a giant step toward proficiency in the present state-of-the-art.

The preceding is just one example of the many approaches to improved and continued proficiency that are available to the technician. There are many others. Choose the one that suits you and keep abreast of what's new in your industry. You have a lot of things to gain by it—the least of which is continued success in your profession. ▲

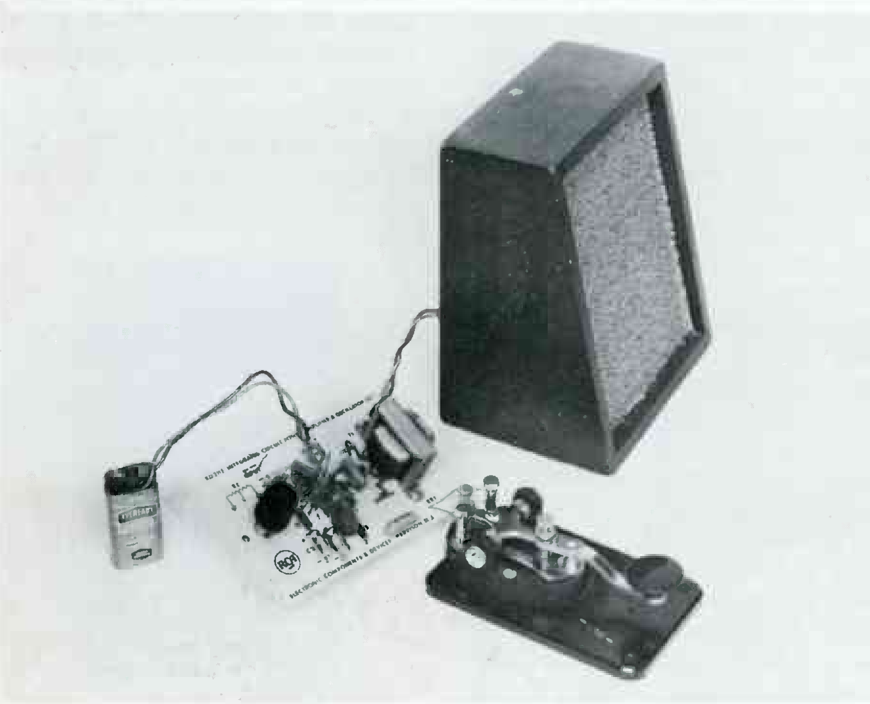


Fig. 5. Audio oscillator constructed from Experimenter's kit.

PHOTOFACT BULLETIN

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis. This is another way PF REPORTER brings you the very latest facts you need to keep fully informed between regular issues of PHOTOFACT Index Supplements issued in March, June, and September.

Clairtone Chassis C15 955-1

Crown AD-105B, B-1350, CTV-12 958-1

Emerson 35PO1, 35PO2 957-1

General Electric
Chassis KD 959-1

Hitachi CNA-24T 958-2
TWA-77 956-1

Magnavox Chassis T924-01-AA, T924-02-AA 956-2

Panasonic TR-205 954-1

Philco-Ford Chassis 18MT70, 18MT70B, 18QT85, 18QT85A 954-2

RCA Victor
Chassis KCS153XB/XC 957-2

Sears Silvertone
Chassis 456.70370 thru 373, 528/529.70370 thru 378 955-2
Chassis 528.70410/411/412 958-3
Chassis 528.71210 959-2

Sony TV-120U, TV12OUD 954-3

Zenith Chassis 14Z21 956-3

Production Change Bulletins

Emerson Chassis 120822A/823A/835A/844A, 120859A/B, 120871A, 120893A/B/C 955-3
Chassis 120829B/830B/831B, 120858A/B 956-4

General Electric
Chassis DB (Code 538 & higher) 957-3

Motorola Chassis ADTS-584, PKTS-584/Y, PNDTS-584/Y, TDETS-584/Y, VADTS-584, WDTS-584/Y 958-4
Chassis CKTS-584/Y, LKTS-584/Y, LADTS-584, TETS-584, TDLETS-584/Y, TPCETS-584/Y 954-4
Chassis DTS-/PDTS-585, DTS-/PDTS-585Y, VTS-/WTS-454 957-3
Chassis TTS-587, VTS-587Y 959-3

Sylvania Chassis 574-3/-4/-7/-8, 575-7/8, 577-1/-2, 581-5/-6/-7/-8 956-4
Chassis BO5-5/-6, DO 1-8 955-3

Circle 22 on literature card

analysis of test instruments . . . operation . . . applications

NOTES ON TEST EQUIPMENT

by T. T. JONES

New Marker Generator

The new Model IG-14 Post Marker Generator from Heath may turn out to be one of the most popular instruments on the 1968 market. While sweep aligning with the IG-14 (and a sweeper and scope), it is no longer necessary to crank a marker back and forth across the video bandpass. You just flip a rocker-switch on or off to control the desired marker birdies.

In actuality, the sweep procedure using the IG-14 becomes so simple that a technician can include an alignment check as a standard step in receiver checkout. Once the equipment is installed on the bench, the time expended for an alignment check should be no more than two or three minutes—from a cold start. The first step would be to connect the IG-14 to your scope, since your scope will probably be used for other tests as well. Next, you connect the sweep generator to the receiver mixer. The simplest method for this step is to use an insulated tube shield. Next, connect the specified amount of AGC clamp bias (the IG-14 has a built-in bias supply). And finally, connect the IG-14 to the receiver video detector.

Fig. 1. New Heathkit marker generator.

At this point, you turn everything on, if you haven't already done so. The IG-14 is instantly ready to go, since it's solid-state. If your sweeper, scope, and the receiver under test are also solid-state, the rest of the job should take about 45 seconds. Otherwise, you can have a cup of coffee while everything warms up. Now, assuming the equipment is all warmed up, you set the sweep generator to 43 or 44 MHz, with about 10-MHz sweep width. You advance the RF gain until the trace deflects, but not so far that the trace shape changes.

Now you have a good picture of the IF bandpass response, except that you don't know whether the frequencies are correct. With a variable marker, you would crank the birdie across the trace, and hope the marker dial is reasonably well

Heath IG-14 Specifications

Marker Frequencies:
100 kHz—Beat marker
3.08, 3.58, 4.08 MHz—Color bandpass.
4.5 MHz—Sound IF.
10.7 MHz—FM IF.
39.75, 41.25, 42.17, 42.50 42.75, 45.00, 45.75, 47.25 MHz—TV IF.
67.25 MHz—Channel 4.
193.25 MHz—Channel 10.

Modulation:
400 Hz.

Input Impedance:
Sweep sample, 75 ohms, External marker, 75 ohms. Demodulated input, 220k ohms.

Output Impedance:
RF output, 75 ohms. Scope, 22k ohms.

Bias Supply:
0-15 VDC, 10ma.

Size (HWD):
5½" x 13½" x 11".

Weight:
8 lbs.

Power Requirements:
120VAC, 7.5 watts.

Price:
$99.95 (kit).

calibrated, and that you can return to the same place on the dial. With the IG-14, you just flip a switch, and a marker appears. Advance the "Marker" control until the marker is of the proper amplitude. Flip another switch, and a second marker appears.

Fig. 2 shows an IF response curve with markers at 41.25 MHz (sound carrier), 42.17 MHz (color carrier), 45.75 MHz (picture carrier), and 47.25 MHz (adjacent sound). This waveform photo was taken with an RCA sweep generator, a Jackson scope, and the IG-14. Some sweep generators need a slight modification to furnish sweep sample to the IG-14; others do not. The modification took about 10 minutes to install in an EICO Model 369 sweeper, and Heath furnished the necessary parts as part of the IG-14 kit.

The kit was simple to construct, and simple to check out. Total construction and check out time was under 10 hours, but it became somewhat tedious toward the end of the job, when we started making the cables. When you start making the cables, it is best to skip on through the manual to the operating procedure to see how the scope and sweep generator are interconnected with the IG-14. Then build your cables with appropriate connectors at each end.

As can be seen in the specification box, there are many other marker frequencies available, in addition to the four mentioned above. Color IF, FM IF, other frequencies in the video IF band, and channels 4 and 10 are included. An RF output jack is furnished so that a modulated or unmodulated CW signal is available. This signal is useful in setting traps, and for presetting stagger-tuned IF systems.

For further information
Circle 40 on literature card

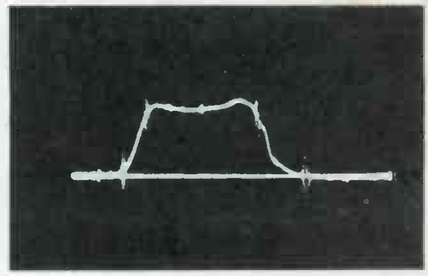


Fig. 2. Markers at all critical points.

Triggered-Sweep Scope

Earlier this year, we mentioned that developments in new scopes have been rather disappointing. Those words had hardly been written when about a half-dozen manufacturers revealed their new models. There are many new features available, and it looks as if 1968 is the "year of the scope." The first of these new scopes to reach our lab is Data Instruments' Model 555, pictured in Fig. 3.

This new scope has triggered

Fig. 3. New triggered-sweep scope.

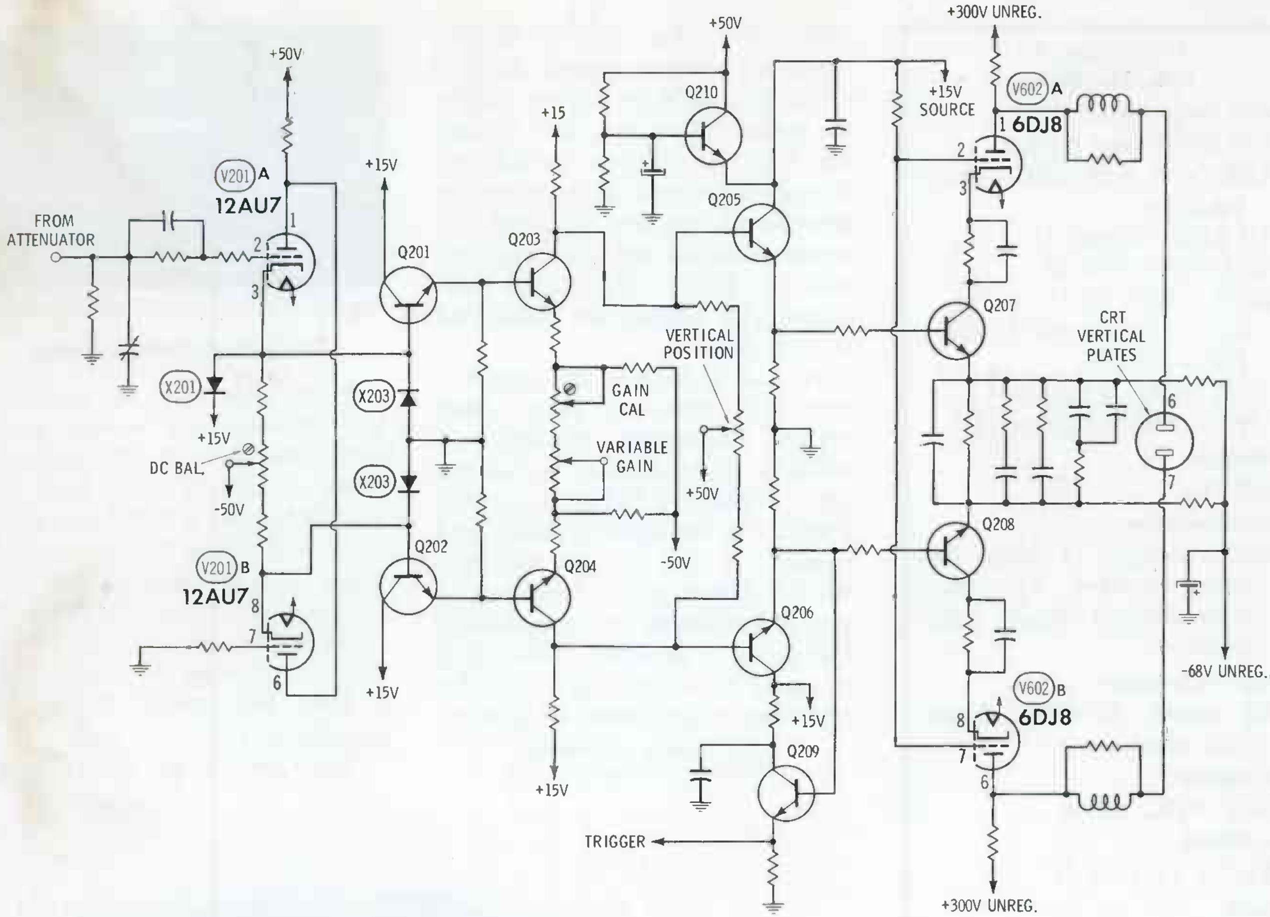


Fig. 4. Simplified diagram of the vertical amplifer stages.

sweep, calibrated time base, calibrated vertical amplifiers, and a built-in, square-wave calibrating source. The scope is conservatively rated as "3 dB down at 7 MHz", but we found it still had plenty of gain at 10.7 MHz. Also, the trigger was still rock-solid at that frequency.

It was quite a surprise to open the case on the Model 555. The first thing noticed was all the Japanese parts. We later learned that the scope is manufactured for Data Instruments by Kikusui Electronics Corporation of Japan. The most interesting internal feature though, was the tube lineup. There were two 6DJ8's and a 12AU7—and a whole lot of transistors. The Model 555 is a hybrid.

Fig. 4 shows a portion of the vertical amplifier section. The 12AU7 cathode followers present a high-impedance load to the input circuits. (The actual input impedance is 1 megohm shunted by 33 pf.) The output of the 12AU7 is fed through a string of transistor stages, to the 6DJ8 output ampilfiers, and finally to the vertical deflection plates. Note that Q209 and Q210 are not symmetrical, through the rest of the vertical stages are. Q209 passes the trigger signal, which is picked off the ouput of Q206.

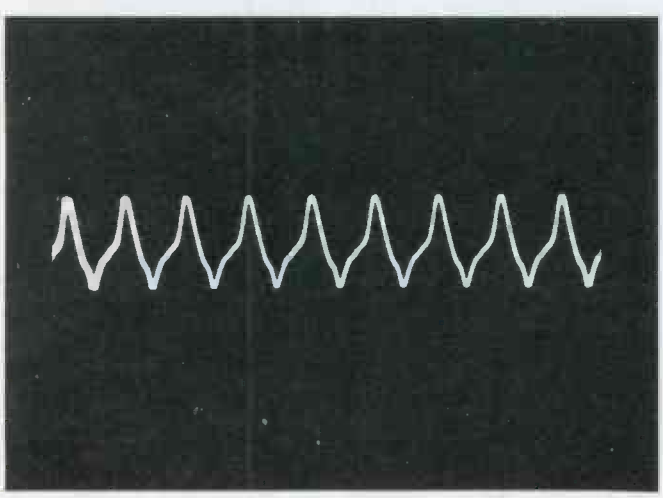


Fig. 5. Scope trace of a 3.58-MHz wave.

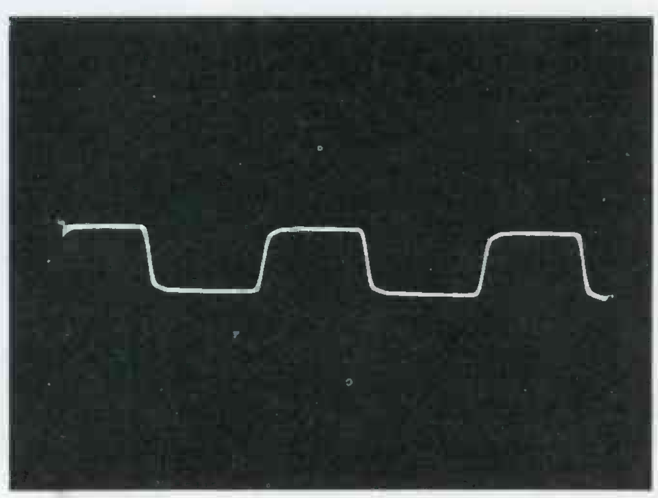


Fig. 6. 1-MHz wave shows fast rise time.

Data Instruments Model 555 Specifications

Vertical Axis

Sensitivity:
.02 V/cm—10 V/cm in a 1-2-5 sequence.

Accuracy:
±3%.

Frequency response:
DC—7 MHz ±3 dB (2 Hz—7MHz when AC Connected).

Rise time:
50 nanoseconds.

Input impedance:
1 megohm shunted by 33pf.

Horizontal Axis

Sweep rate:
1 us/cm—1 sec/cm in a 1-2-5 sequence with 5× expander.

Accuracy:
±5%.

External sensitivity:
.2 V/cm—10 V/cm, continuously adjustable.

Response:
2Hz—200 kHz ±3 dB

Input impedance:
1 megohm shunted by 40pf.

Trigger

Internal:
20 Hz—7MHz with 1 cm deflection.

External:
20 Hz—7MHz, 1V p-p.

Calibrator

Wave shape:
1-kHz square wave.

Amplitude:
5, 0.5, 0.05 V p-p.

Accuracy:
±3%.

Power requirements:
117 VAC, 40 watts.

Size (HWD):
11½" x 8" x 17½".

Weight:
24 lbs.

Price:
$284.

Q210 provides the +15-volt source.

The rest of the vertical stages are quite similar to previous scopes, except that the stages are transistorized. The same holds true throughout the scope: The calibrator is a conventional multivibrator, the time-base trigger is a Schmitt circuit, and so on, except they're all transistorized.

As previously mentioned, the Model 555 has a very stable trigger. So stable in fact, that the "Stability" control is a screwdriver adjustment. Fig. 5 shows a 3.5-MHz signal locked in solid. Another good example of this scope's stability are the composite waveform photos in this column in the April issue. With many scopes, a composite waveform is a bit difficult to lock.

An example of the scope's flatness and rise time can be seen in Fig. 6. This photo shows a 1-MHz squarewave. Note that there is comparatively little rounding of the leading and trailing edges, indicating good responses to 10 MHz. The system rise time is approximately 40 nanoseconds. We were using a Hewlett-Packard Model 213 generator, which has no more than 20 nanoseconds rise time, so evidently the scope rise time is pretty good. The manufacturer's specifications for the Model 555 claim 50 nanoseconds rise time.

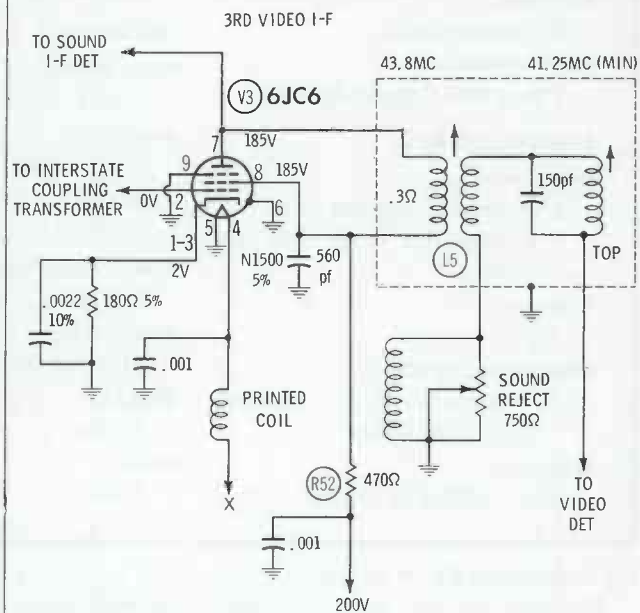
Along with the good, there must be a few features we don't particularly like, and the Model 555 had these too. The most obvious is a lack of dimmer on the scale illumination. It's either on or off—no in between. However, there is plenty of room to install a control where the switch is located, so for a dollar or so, this problem is easily solved.

Less easy to solve is the lack of delay lines in the vertical sweep amplifier. For general servicing, this is no problem, but for specialized applications such as watching an event or onetime pulse, the leading edge of the waveform will be lost. Fig. 6 shows how much of the wave is lost. All in all, though, the Model 555 is a lot of scope for the price. ▲

For further information Circle 41 on literature card

COLOR COUNTERMEASURES

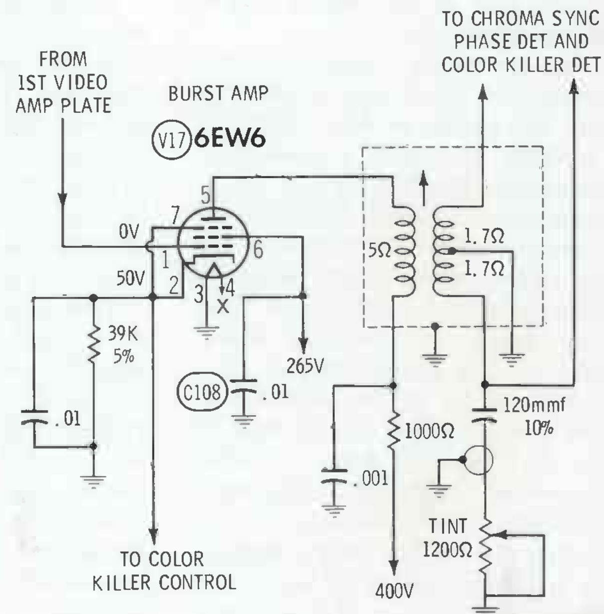
SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE



Chassis: RCA CTC25

Sympton: Raster, but only a squeal in the sound and no picture.

Tip: Check voltage on pins 7 and 8 of V3, 3rd video IF. Possible trouble is a defective decoupling resistor, R52.



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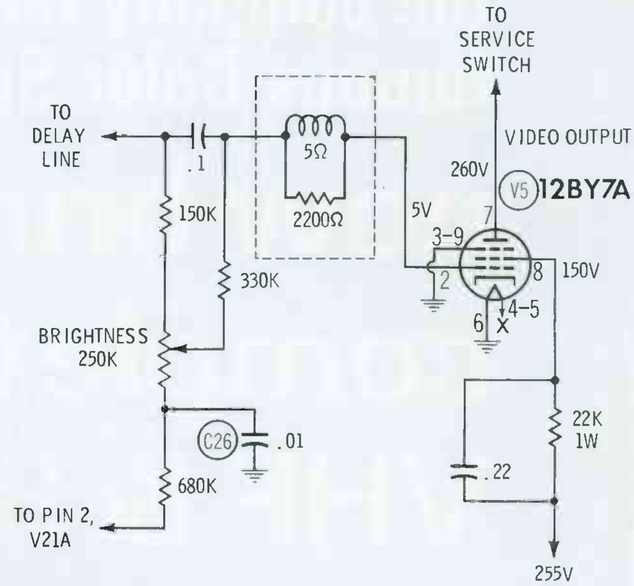
Circle 25 on literature card

Chassis: RCA CTC15AE

Symptoms: Sound, picture, and brightness missing.

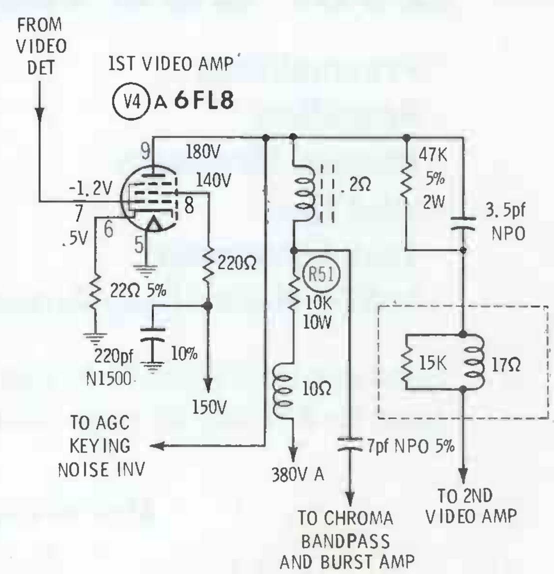
Tip: Before performing normal troubleshooting procedures in the IF section, check the 265-volt source. Possible trouble is a shorted C108 in the screen grid circuit (pin 6) of the burst amplifier, V17.



Chassis CTC16X

Symptom: Picture appears dark. Rotating brightness control has very little effect on brightness.

Tip: Check voltages on V5, the video output tube. If resistance from pin 2 to ground on V5 is low, possible cause is shorted C26, which grounds one end of the brightness control. This will also effect voltages on V21A, the horizontal blanking amplifier.



Chassis: Airline Model GHJ 7537A.

Symptoms: Washed out picture; fine detail in picture appears blurred; weak color.

Tip: Rotating the contrast control or advancing the AGC control makes little difference in the picture. Check plate voltage on plate (pin 9) of 1st video amplifier. Possible cause is increase in value of R51. plate load resistor. Replace defective resistor.▲

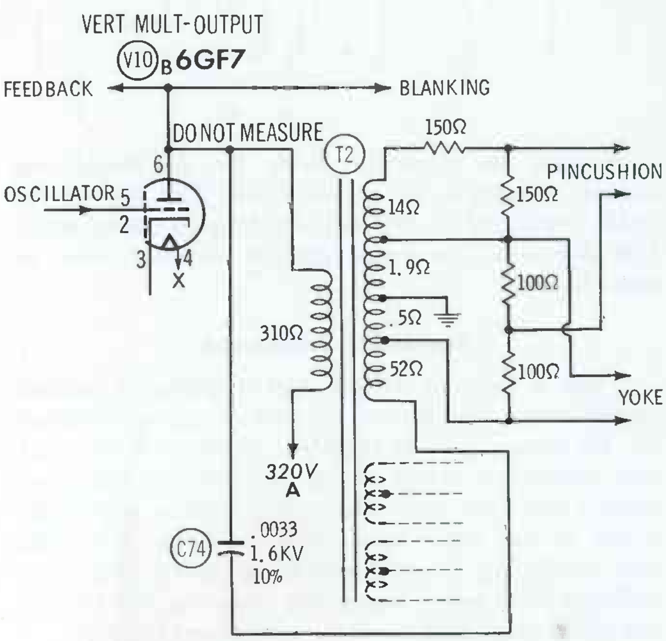
THE TROUBLESHOOTER

Vertical Jitter

I had an unusual problem which I would like to share with your other readers. An RCA CTC17 (PHOTOFACT 779-3) came into the shop with symptoms of vertical jitter. After considerable troubleshooting, the problem was traced to C74 in the plate circuit of the vertical-output tube. When one side of this capacitor was unsoldered, the set operated normally. An ohmmeter showed the capacitor was leaky, but with very high resistance.

CHARLES JACKSON

Buckner, Illinois



Since we haven't run into this problem, we can't say for sure, but we doubt if the set "operated normally" with C74 out of the circuit. It appears that the capacitor helps balance the phase between the primary and secondary of T2. Without the capacitor there would probably be a loss of interlace.

Bad Flyback

I had a Zenith 14M23 which had a bad flyback transformer. After replacing the flyback, the high voltage was way down—about 6kv. Naturally, I first checked all connections on the new flyback, and during this inspection I discovered that the ferrite core was cracked, so that there was a definite air gap in the core. I mixed up some epoxy glue and glued the core tightly together. The high voltage then returned to normal.

I think the core might have been cracked during replacement, as it must be mounted in a bracket which is subjected to some strain during the mounting procedure.

CHARLES CATTERMOLE

Pleasantville, N. J.

From the photos in the service literature, it appears that flyback replacement could present problems in the 14M23 and similar Zenith chassis. Care should be taken to avoid straining the ferrite. Your method of repair (epoxy) seems to have worked, but we think that a magnetic cement should have been used. There are several brands of magnetic cement on the market, as well as actual ferrite epoxies. Using these glues should give a bond more closely approaching the original condition of the ferrite core.

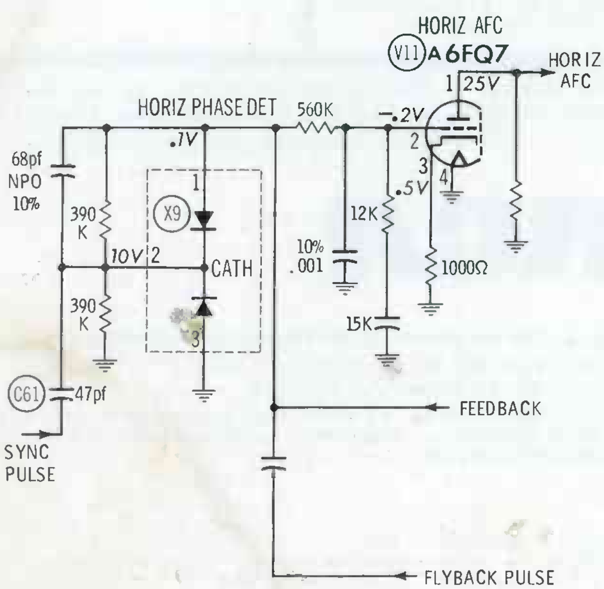
Weak Horizontal

I've had many cases of weak horizontal sync in RCA chassis such as CTC 16, 17, 19, etc. Most people jump on the phase detector diode, which is fine. But after checking this, and other components in the AFC circuit, even completely rebuilding the circuit, the trouble may still exist. The picture flops over during station breaks, when changing channels, etc.

I have found that changing the sync coupling capacitor (C61) from 47 pf to 100 pf will clear up the problem.

WILLIAM WHITE

Madison, Wis.



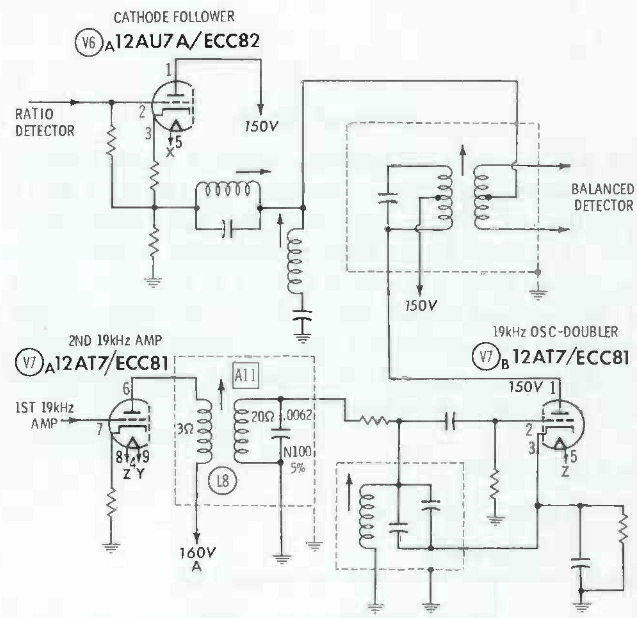
Although we do not ordinarily advocate circuit modifications, this tip may be valuable for those stubborn cases.

Motorboating MPX

A Pilot 602M (PHOTOFACT 625-12) stereo receiver was brought into the shop with a complaint that it would break into motorboating several times each day. On the bench, I found the condition could be introduced at will be interrupting the antenna circuit. When I put a scope probe on the plate of the cathode follower V6A, the trouble would clear up. This plate returns directly to the B+ supply with no dropping resistor—not much of a clue. Further scope checks showed that the 19kHz oscillator-doubler was disabled during motorboating, and that L8 would not peak. Replacing L8 restored the set to normal operation.

RODNEY SCHROCK

Somerset, Pa.



Probably the capacitor inside the L8 shield was opening, causing a loss of pilot signal. This allowed the 19kHz-oscillator to free-run, resulting in out-of-phase L-R detection. The usual result is squawks, howl, or motorboating.

Too Much Brightness

I had a Sylvania D02-2 that displayed a normal picture when first turned on, but as the set warmed up, the screen got too bright. It acted as if the CRT bias switch was in the wrong position; the brightness control had very little effect. The trouble was finally traced to the video output tube, a 6JT8. This tube was developing a small amount of grid leakage. An ordinary tube tester would not show up the trouble; the tester must have a very sensitive leakage test.

WILLIAM BROWN

Vine Grove, Ky.

Another point scored against the "drugstore" tube tester. Most laymen suspect these tube testers will sell them tubes they don't need, but in our experience the *drugstore tube testers are much more likely to pass bad tubes than reject good ones.*

Most modern tube testers, designed for use by technicians, have very sensitive tests for grid leakage. In cases such as above, where the trouble does not show up for several minutes, the gas test can be accelerated by applying a higher-than-normal heater voltage (about 7½ or 8 volts for a 6-volt tube) to preheat the tube. The heater voltage should be returned to normal before reading leakage. The high heater voltage will more quickly release any gas molecules present in the tube. However, this method should not be used on frame-grid tubes, as damage is likely to result.

A Short Note

I have a problem with Sears #528-51784 set, Sams #601. A wide white bar starts at the bottom of the picture and slowly creeps upward, vertical lines are twisted through the thickness of this bar. Please advise the source of the trouble.

R. F.

New York

The above letter is printed in its entirety as an example of a large portion of the letters we receive. If R. F. has made any checks or measurements, he hasn't told us about them. We all know that it is usually difficult to find the source of the trouble solely from the screen symptoms. In this case, we've heard of the problem before. The Sears chassis in question had more than its share of this symptom, and it was usually caused by C11, the AGC filter. But please men, give us a few measurements on which to base our diagnosis.

Gassy(?) Tubes

I have a new RCA CTC28 in which the 6AQ5 audio-output and the 12BY7 video-output tubes have a bluish glow, even though the set appears to be operating normally. Some sources of servicing information reccommend replacement of gassy tubes, but my tube tester does not have a gas test. Is it alright to use these gassy tubes?

H. Cave

Ferguson, Mo.

It is important to distinguish between the glow caused by gas and the glow caused by fluorescence. The glow caused by gas is usually pale blue and often has a "flat" appearance. The unique feature of gas is that the glow is present inside the elements of the tube—between the cathode and plate.

Fluorescence glow is usually a bright, glossy, blue, and it appears on the inside surface of the tube **envelope** *—not inside the tube* **elements.**

Fluorescence appears in nearly all beam-power tubes, and can be considered "normal." Gas, on the other hand, is a definite defect (with the exception of mercury-vapor rectifiers, thyratrons, etc.) Gassy tubes can cause distortion in audio circuits, ghosts in IF circuits, twist in AGC circuits, and a host of other symptoms. In some cases, a gassy tube will cause no definite symptoms, except premature failure of circuit components—especially cathode and plate resistors. ▲

Book Review

Understanding Silicon Controlled Rectifiers: Saul Heller, Hayden Book Company, Inc., New York, New York, 1968; 134 pages, 8¼" by 5½", soft cover; $3.50.

This informative book explains the many uses of the Silicon Controlled Rectifier (SCR) in a language that both the technician and engineer will understand. The author has used over 30 illustrations and over 40 circuit diagrams to provide the reader with a good description of the application and operation of the SCR as a solid-state switch.

Chapter 1 covers the construction of semiconductor units and includes the many factors that influence their behavior. This review of basic theory provides a good background for understanding the applications that are explained later in the text.

The SCR and how it works is explained in Chapter 2. How it is turned off and on, the voltage and current characteristics, what takes place during switching, and why the SCR is efficient are a few of the many details discussed.

Eleven methods of triggering an SCR, with circuits for each, are shown in Chapter 3. The following chapter discusses three methods of turning the unit off, along with several circuits associated with this aspect of SCR operation.

Chapter 5 illustrates the different types that make up the family of SCR's. The next three chapters cover the specific applications of the SCR. Information about such applications as the proximity switch and touch switch provide the reader with adaptations of the SCR that are surprisingly commonplace. The twenty-five applications mentioned in these chapters represent only a fraction of the many common uses to which the SCR is adaptable.

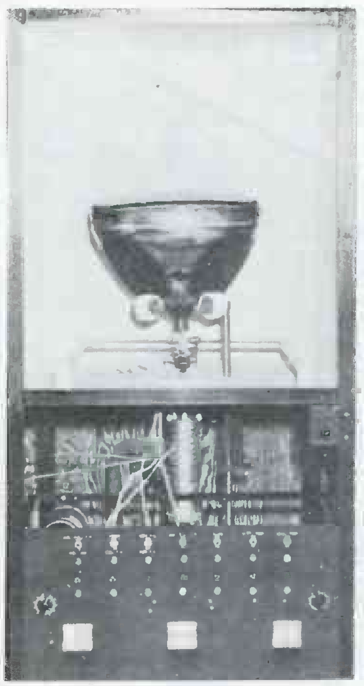
The final chapter covers a lot of ground in a very few pages. Time parameters, temperature, cooling, maximum ratings of voltage and power, reverse breakdown ratings and factors affecting applications are the main topics. A list of available test equipment for checking characteristics and a general discussion of service tips provide a good conclusion. ▲

PRODUCT REPORT

for further information on any of the following items, circle the associated number on the Catalog & Literature Card.

CRT Rebuilder
(50)

The picture tube rebuilding machine shown here features all-welded seams, vertical operation, and industrial-type vacuum and diffusion pumps. The **Lakeside Industries** unit



operates on regular house current in a space required for one office desk. Four tubes an hour can be rebuilt at an average cost of $2.00 or less for b-w and $10.00 or less for color tubes. Price of the equipment with all necessary supplies is $5000.

Battery Charger
(51)

The new Perma-Cell battery system by **General Electric** provides one answer to the problem of keeping a supply of batteries for the many new types of portable units on the market.

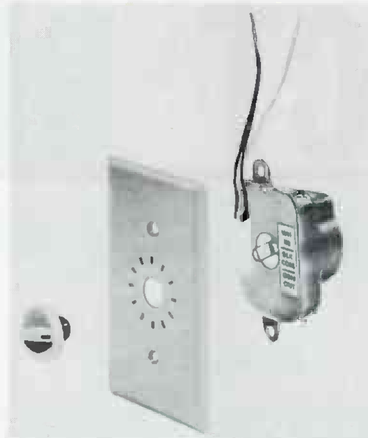
The two elements of this system are the battery charger and nickel-cadmium batteries. The charger accomodates the three most popular battery types—types "D", "C", and "AA". The unit operates on 110 volts AC and can simultaneously charge any combination of batteries.

The unit is a transformer-type charger that provides proper current regulation and isolates the user from household current. The design of the system prevents charging batteries in reverse. Two charging rates are available: ½ ampere hour for "AA" type and 1 ampere hour for "C" and "D" types. The new Perma-Cell batteries can be recharged 1000 times or more.

The charger Model BC1 measures 7⅛" long by 5½" wide by 2½" high. Price is $9.95. Battery prices are $3.95 per pair for "D" and "C" types and $3.49 for "AA" type.

Level Control
(52)

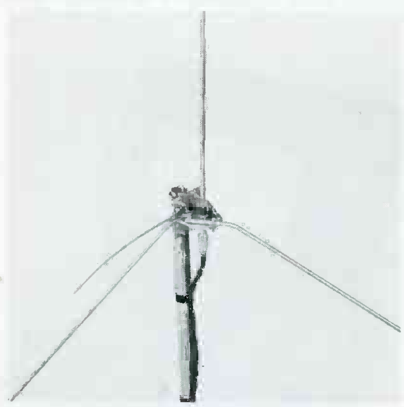
A complete new line of audio level controls has been announced by **Jensen Manufacturing Company.** Speaker loads of 5 watts and up to 75 watts with attenuation variable up to 27 dB with an "off" position is available. The 5-watt type uses a wire-wound potentiometer, while the higher wattage types use a tapped resistance and an autotransformer. A vacuum-formed cover of high-impact plastic encloses the electrical components, providing protection against short cir-



cuits. A push-on knob is provided, and optional wall plates with "clock" points are available. The control mounting bracket matches any standard single or double electrical wall box. The 5-watt control, Model LC-85, sells for $6.80, while the 75-watt unit, Model LV75, is priced at $22.50.

CB Base Station Antenna
(53)

This 27-MHz ground-plane antenna has been introduced by **New-Tronics Corp.** The model GP-1 is a low cost, lightweight vertical ground plane. It features ease of assembly and adjustment. Price is $10.95.



Square-Wave Generator
(54)

This new square-wave generator, although compact and light (4 lbs.), is a general-purpose laboratory instrument with a wide frequency range (1 Hz to 10 MHz) and less than 15 ns rise- and fall-times. The **Hewlett Packard** unit's all solid-state circuitry supplies square waves with amplitude

controllable from 0 to 5 volts p-p into a 50-ohm load.

Frequency is selectable in seven decade ranges. A vernier selects the exact frequency desired within any one of the 10-to-1 frequency ranges. Vernier frequency control can also be accomplished by applying an external voltage.

A DC voltage adjustable between −1.2 and −13 volts gives frequency control over a 10-to-1 range. Hence, the instrument qualifies as a voltage-controlled oscillator (VCO). Voltages between 0 and −1 volt suppress square-wave generation so that the VCO input may also be used to gate the generator's output.

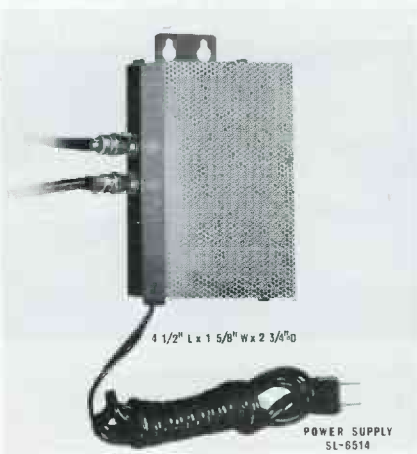
Source impedance is 50 ohms; this preserves the clean wave shape by absorbing reflections from impedance mismatches on the output cable. (If the source impedance were not 50 ohms, reflections would be re-reflected, distorting the waveform.)

The Model 220A measures only 5⅓" wide by 3⁷⁄₁₆" high by 11⅝" deep. Price is $195.

MATV Power Supply

(55)

A new 17-volt DC power supply capable of handling up to five MATV amplifiers has been announced by **JFD Electronics.** The model SL-6514



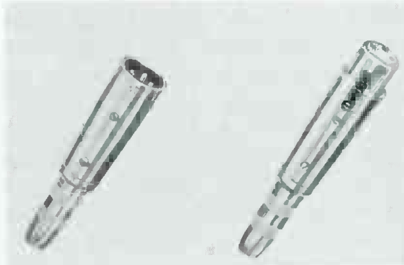
power supply is regulated so that the output voltage will not vary more than 2% during load changes up to 10:1 and line-voltage swings of ±10%. Intended for indoor mounting, it sends 17-volt DC to remotely located amplifiers along the same coaxial cable that carries the RF signals. RF signals from 54 to 890 MHz pass through the unit with negligible loss. Input and output impedance are 75 ohms. The unit measures 4½" long by 1⅝" wide by 2¾" deep. Price is $37.50.

Conector Adapters

(56)

Two audio connectors have been introduced by **Switchcraft, Inc.** They are designed to solve common interconnecting problems on components that do not have mating connectors.

One adapter connects a standard two-conductor phone plug to equip-



ment that uses a three-pin audio receptacle. The other adapts a standard two-conductor phone plug to equipment using a three-contact audio receptacle. Both new adapters feature a separate ground terminal that provides ground continuity between mating plugs, and a left-handed threaded insert screw. Price for the No. 383P1 is $4.75. No. 384P1 is priced at $4.25.

Loudspeaker

(57)

Shown here is a voice speaker designed for the electronic musician. This horn, featuring a peak music power of 125 watts, is intended for use as an auxiliary speaker to handle the vocals of musical groups. The **Atlas Sound** BANSHEE loudspeaker (Model CJ-125) is for use on a speaker stand, two models of which are available by the manufacturer—the SS-2 and SS-4.

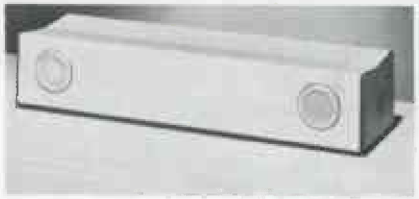
The new loudspeaker, a cobra-flare horn, is fabricated of unbreakable fiberglass in jet black with a red re-entrant assembly. It measures 23″ wide by 13″ high by 19″ deep and has a weight of 20 lbs. The speaker has a frequency response of 100-12000 Hz, a sound intensity of 131 dB and an input impedance of 16 ohms.

The speaker utilizes a built-in, pre-wired phone jack so that no wiring or soldering to the speaker is necessary. Insert a speaker cable having a two-conductor phone plug, and the unit is ready to operate. Price is $121.00.

Intrusion Alarm

(58)

This alarm responds to any moving object within a 20′-30′ range. It can be used both indoor and outside to protect an equivalent space. Two sockets on the rear provide for connection of external lamps or bells. Protection of larger areas can be accomplished by using two or more units. The **Euphonics** Model A-1 is supplied in

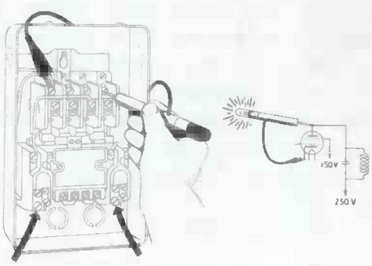


four different ultrasonic frequencies to prevent interaction between them. Price is $97.50.

Circuit Tester

(59)

Shown here is an electrical circuit tester that can measure AC or DC up to 500 volts. It can be used in a variety of applications including radio,



TV, automotive, and electrical servicing. The **Burnworth** tester is self-powered and is equipped with a 48″ insulated lead wire terminated in an alligator clip. Price is $2.98. ▲

Advertisers' Index

FREE

Catalog and Literature Service

**Check "Index to Advertisers" for additional information.*

ANTENNAS

100. *ANTENNACRAFT*—4-color brochures describing Channel Spanner and Custom Channel Spanner Series Antennas for UHF, VHF, and FM.
101. *BLONDER-TONGUE* — 24-page product guide to TV-FM reception products.
102. *FINNEY*—4-color brochure with description and technical details on new Finco Color Spectrum frequency-dependent antennas for UHF-VHF-FM, VHF-FM, and UHF. Form 20-413.*
103. *GAVIN INSTRUMENTS*—6-page folder illustrating the complete outdoor antenna line, converters, and accessories with technical data.*
104. *JERROLD*—Complete catalog on antennas, reception aids, and TV distribution equipment (Form No. DS-C-1054).
105. *JFD*—New 40-page Dealer Catalog of TV-FM antennas and accessories.
106. *MOSLEY*—Catalogs on CB, amateur radio, and TV/FM antennas.*
107. *RMS ELECTRONICS* — Illustrated specification sheet describes eight "Direction-Finder" UHF, VHF, and FM antennas.*
108. *WINEGARD*—Fact-finders on "color-tracker" UHF antennas and a solid-state 4-set booster-coupler.

AUDIO

109. *ATLAS SOUND*—Form No. 2537 describes the "Banshee" voice speaker for music groups.
110. *ELECTRO-VOICE*—Pocket-size guidebooks for microphones, hi-fi loudspeakers, and hi-fi systems.*
111. *UNIVERSITY SOUND*—New 28-page 1968 catalog describes speakers, horns, drivers, microphones, sound columns. Includes formulas and technical data.

COMMUNICATIONS

112. *AMPHENOL*—2-color spec sheets on new Model 650 CB transceivers and Model C-75 hand-held transceiver.
113. *MARK PRODUCTS CO.* — Brochure about the "Mark Invader 23" AM CB transceiver.

COMPONENTS

114. *BELDEN*—Catalog 876, a 56-page catalog of the complete Belden line.
115. *BUSSMANN*—New 1968, 16-page car and truck fuse list. Shows what fuse protects—proper fuse to use and where fuse is located. Also shows what BUSS fuse to use in servicing foreign cars and trucks. Ask for BUSS form AWC.*
116. *CENTRALAB*—24-page replacement parts catalog 33GL.
117. *CORNELL-DUBILIER* — New 4-page Color-lytic list.*
118. *IRC* — Brochure describing new "Snap Pak" resistor package.
119. *JENSEN* — Brochure 242 — "Hi-Fi Speaker system components", containing a graphic presentation of 2, 3, and 4-way Hi-Fi Systems.*
120. *LITTELFUSE*—Pocket-sized TV circuit-breaker cross reference, CBCRP, gives the following information at a glance; manufacturer's part number, price, color or b-w designation, and trip ratings.*
121. *MALLORY* — Bulletin 4-82 describes radial- and axial-lead tantalum capacitors.
122. *MILLER*—Catalog 167, a 156-page general catalog with complete cross-reference guide.
123. *POMONA*—New 1968 catalog. A 44-page listing of the complete line with technical information.
124. *QUAM-NICHOLS* — Catalog No. 67 has information on the entire line.*
125. *TEXAS CRYSTALS*—12-page catalog of crystals including engineering data, specifications, and prices.
126. *TRIAD* — Engineering bulletin on toroidal and power inductors.
127. *WORKMAN* — New cross-reference for VDR's and thermistors used in color TV.

SERVICE AIDS

128. *CASTLE TUNER*—Fast overhaul service on all makes and models of television tuners. Shipping instructions, labels, and tags are also included.*
129. *GC*—Catalog FR69, a 304-page listing for all product divisions.
130. *INJECTORALL*—Catalog of Chemicals and Tools including new printed circuit kit.*
131. *PERMA POWER*—Catalog of briteners and TV service accessories.

SPECIAL EQUIPMENT

132. *ATR*—Literature about DC-AC inverters up to 6000 watts load.
133. *CONCORD*—Catalog sheet on a new camera for VTR and closed circuit use.
134. *EUPHONICS*—Catalog sheet on MA-2 Ultrasonic Intrusion Alarm, for boats and trucks.*
135. *KEARNY* — 8-page brochure about Shock-Shield panel and portable units.
136. *STANDARD KOLLSMAN*—Flyers describe replacement TV tuners, built-in UHF converters, external UHF-to-VHF and VHF-to-UHF converters, and contact cleaner kits.
137. *VECTOR* — Literature on the new D.I.P. Plugboards.

TECHNICAL PUBLICATIONS

138. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describing electronics slide rule, four-lesson instruction course, and grading service.*
139. *RCA INSTITUTES*—New 1968 career book describes home study programs and course in television (monochrome and color), communications, transistors, and industrial and automation electronics.*
140. *SAMS, HOWARD W.*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1968 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

141. *ABBEY*—Brochures about the Digimeter and Digiprinter.
142. *B & K* — Brochure ST-32B about B & K Test Equipment.*
143. *EICO*—New spec sheet describes Model 100A4 multimeter with DC sensitivity of 100K ohms per volt.
144. *LECTROTECH* — Two-color catalog sheet on new Model V6-B color bar generator gives all specs and is fully illustrated.*
145. *PRECISION APPARATUS* — Bulletin PST-35 describes test equipment line.
146. *SECO*—Operating manual for Model 260 dynamic in-circuit transistor tester.
147. *SENCORE*—New 12-page catalog on all Sencore products.*
148. *SPRAGUE*—Bulletin describing new Capacitance Meter.
149. *TRIPLETT*—2-color, 12-page catalog, 52-T includes technical characteristics of complete line of VOM's and test equipment.*

TOOLS

150. *ARROW*—Catalog sheet showing 3 staple-gun tackers designed for fastening wires and cables up to ½" diameter.*
151. *ENTERPRISE DEVELOPMENT*—Brochure from Endeco demonstrates improved desoldering and resoldering methods for speeding and simplyfying operations on PC boards.*
152. *SWING-O-LITE* — Catalog sheet on Models BBM-9 and BB-45 bench lamps.
153. *XCELITE*—Bulletin N867 describes hollow-shaft nutdrivers which speed locknut/screw adjustments.*

TUBES AND SEMICONDUCTORS

154. *GENERAL ELECTRIC*—Entertainment semiconductor almanac, ETR-43--C, and picture-tube replacement guide, ETR-702K are offered.*
155. *RCA*—1D1304, a 12-page brochure on RCA's line of all-new HI-LITE color picture tubes for the replacement market. Explains latest technological advances, such as brightness, Perma-Chrome and unity current ratios.*

RCA HI-LITE... the replacement picture tube with "new set" quality

Offer your customers a replacement color picture tube that truly meets OEM specs! RCA HI-LITE picture tubes are RCA's best... the same quality... the same tubes... that go into original equipment sets... with **all new glass, gun, the works.** And because they incorporate the latest technological advances of the world's leading color picture tube manufacturer, they offer picture brightness and color fidelity at its finest. Serving your needs with the broadest line of types in the industry, including 15-inch, 19-inch, 22-inch and 25-inch rectangular and 21-inch round tube types. RCA Electronic Components, Harrison, N. J.

RCA